

Project Title: Angry Penguins



Standard Focus: Algebra, Patterns, & Functions

Time Range: 3-5 Days

Supplies: Basic Stuff, Scissors

Topics of Focus:

- Piecewise Functions
- Transformations
- Continuity



Benchmarks :

Interpreting Functions	F-IF	1. Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then $f(x)$ denotes the output of f corresponding to the input x . The graph of f is the graph of the equation $y = f(x)$.
Interpreting Functions	F-IF	4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.
Interpreting Functions	F-IF	5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.
Interpreting Functions	F-IF	7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.★
Interpreting Functions	F-IF	7a. Graph linear and quadratic functions and show intercepts, maxima, and minima.
Interpreting Functions	F-IF	7b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.
Interpreting Functions	F-IF	7d. (+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.
Interpreting Functions	F-IF	7e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.
Building Functions	F-BF	1b. Combine standard function types using arithmetic operations.

Procedures:

A.) Students will complete “Parabolic Destruction” to begin practicing using quadratic equations and maneuvering the quadratic cut-outs (PROVIDED). Have each student cut out the four paths from “Launch Paths”. They will need to keep the equations of the functions and they will use them for the entire project. The idea of moving the cutouts on the graphs will be different, but it is a useful concrete transformation skill builder. Giving this parabola assignment will allow student to get familiar with a new modality, but not be overwhelmed with content.

The goal in the assignment is to “Poof the Seals”. When one of the path intersects a Seal, it goes POOF. A couple notes: The Penguins will pass through all objects and continue on their path. They can Poof more than one Penguin. The four different paths provided ARE PERFECTLY TO SCALE.

Working with partners is ideal throughout this assignment.

More instructions are included on the student assignments. Definitely review them before you give it a go because this is different.

B.) Hand out “Launch Path Reference Sheet” these are the coordinates of the different functions for the durations of their flights. The points with two integer coordinates are highlighted. Hand students Launch Path Analysis for a quick assignment (which will also be used for reference later). Students will analyze the data table to draw conclusions about the functions.

C.) Students will complete “Piecewise Power-Ups”. To get started have students cut out “New Recruits”. There are different functions, and they are also perfectly to scale. On New Recruits, students are also given a general equation to transform the function. The X’s noted on the functions are required to be on the same point as an integer coordinate of the parabolic path. Students will need to use the general equation they are provided to write Piecewise functions. An example is provided and the first few questions are simpler to help scaffold. Moving the functions around on their paper will be useful in reteaching transformations. The only oddball is that with the Exponential function there is an additional subtraction of 1 to allow for integer points to line up with integer points.

ALL Power-Ups are continuous functions. There should not be any discontinuity in this assignment.

D.) Students will complete “Angry Penguins”. This will use the cutouts and skills from the previous assignments and ask students to tie together all of the skills. Students will have a variety of answers to solve the problems. In the answer key I have only provided one answer that does work for each. There are five levels in all. You can have a prize for the team that “Beats the game first”.

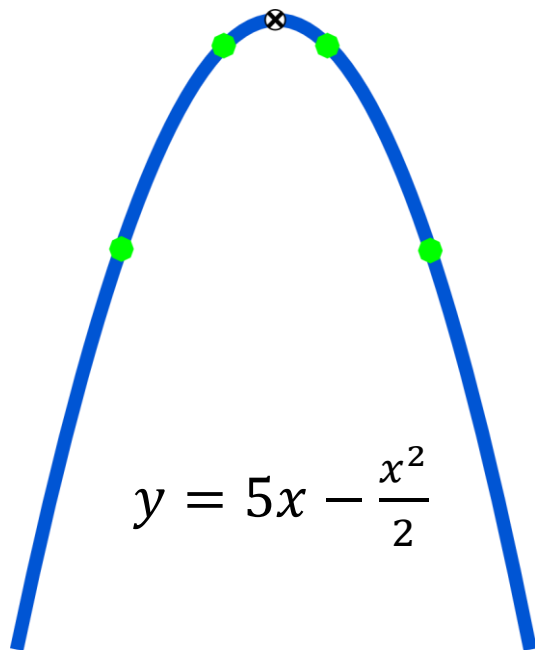
E.) Optional** Students will complete “Create Your Own Angry Penguins Level”. This could be left as a homework assignment. Students will enjoy this assignment throughout and they may crave a little extra. You could even collect students levels to pass them around randomly in your class for an impromptu quiz. Lots of possibilities 😊

Math it Up. Enjoy! 😊

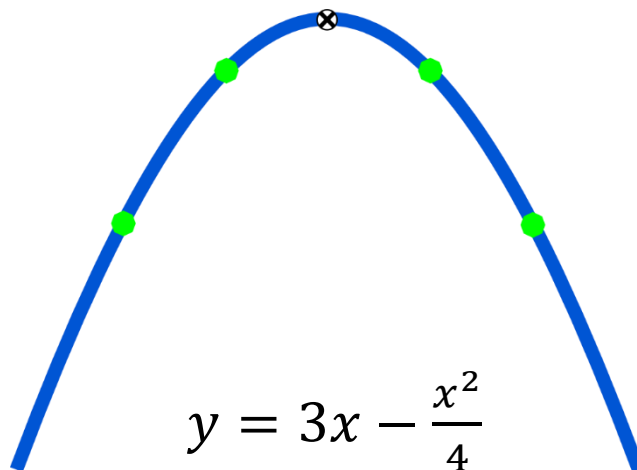
LAUNCH PATHS

(CUT OUT TO USE -- THEY ARE TO SCALE)

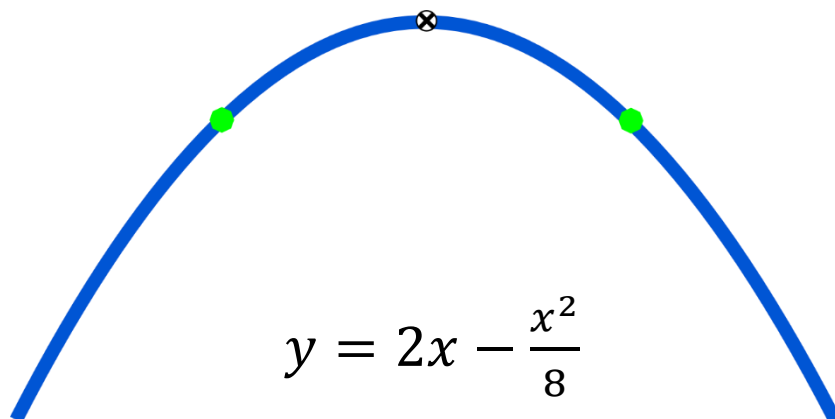
PATH A



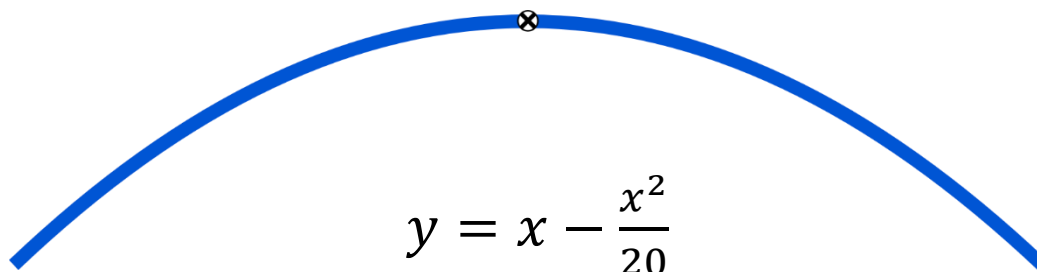
PATH B



PATH C



PATH D



PARABOLIC DESTRUCTION

In American culture people have an affinity for launching birds, pheasants and other sorts of fowl at oblivious targets with a sling shot. Where does this fascination come from? Nobody knows. Nonetheless, it makes for an interesting quadratic function application. Are you ready to help out costumed Penguins extract centuries of revenge against those slap-happy menacing predators -- the Seals. Of course you are.

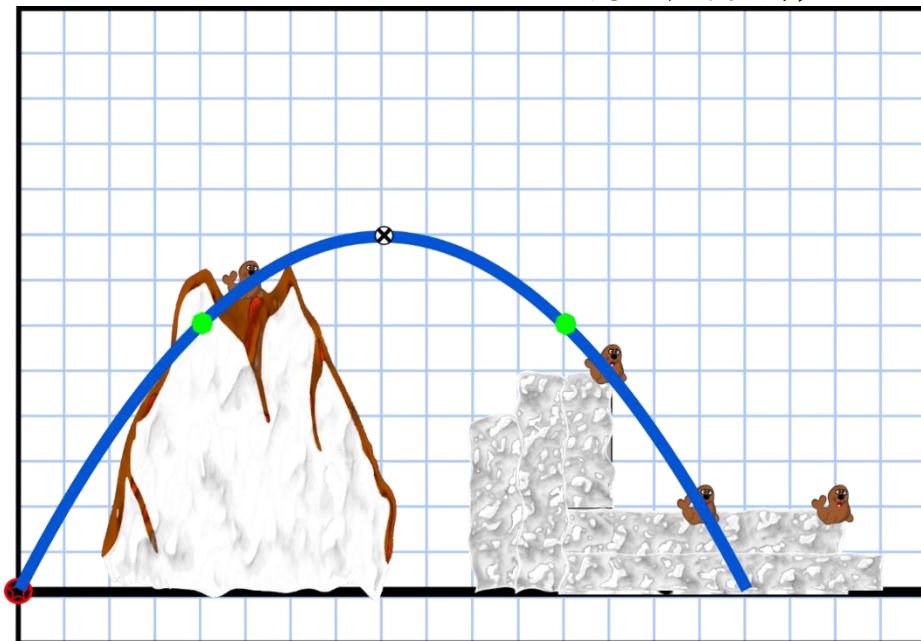


Kung Fu Penguin

Cut out the four "Launch Paths". These will be needed throughout this entire project. To launch a Penguin, you will select one of the four launch paths. Each time the parabolic path crosses a Seal, the Seal goes "poof". You can mark each "poofed" Seal with a dark, very angry X. The object of the game is to make all of the Seals on the gameboard go "poof".

Under each gameboard you will see which Penguins you can use. Only the Kung Fu Penguin will be used at this point, but other Penguins will be introduced later. After each Penguin is launched, you must record the equation of their trajectory. All Penguins will pass through any obstacles on their path.

- FOR EXAMPLE -



EQUATION

SEALS
POOFED

1.	$y = 2x - \frac{x^2}{8}$	3
2.		
3.		

In this example, there are three Kung Fu Penguins that you can use. The first Penguin was launched with at Path C ($y = 2x - \frac{x^2}{8}$) and it poofed three Seals. One Seal remains for the next round and the player would have to figure out a combination that will make them Poof.

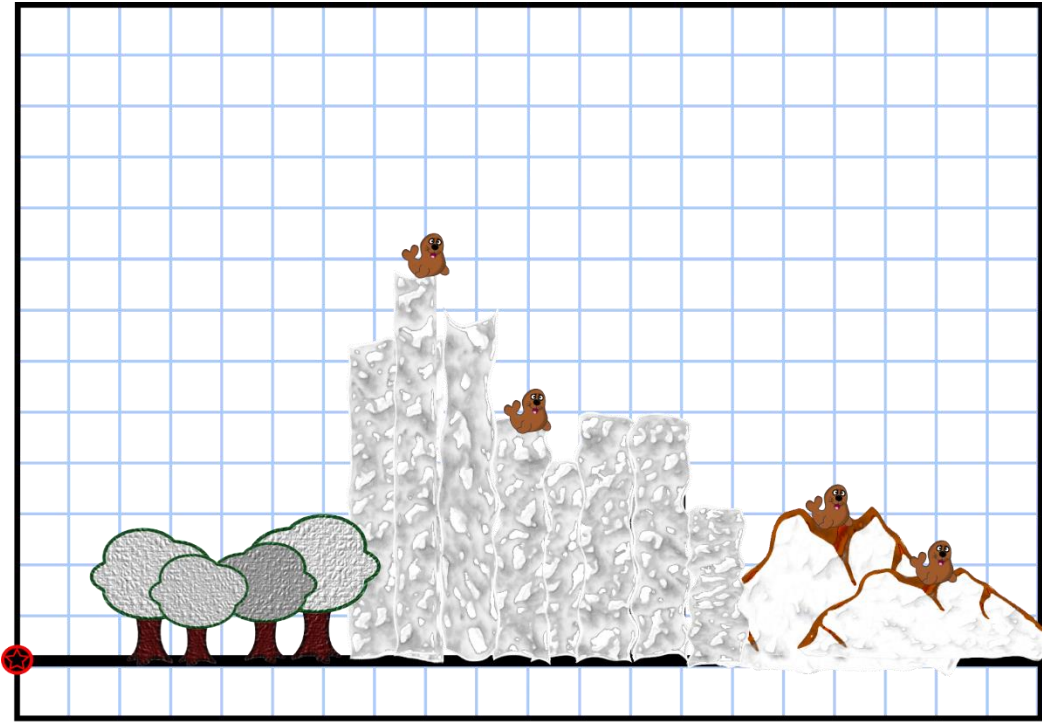
Name _____

Date _____

Period _____

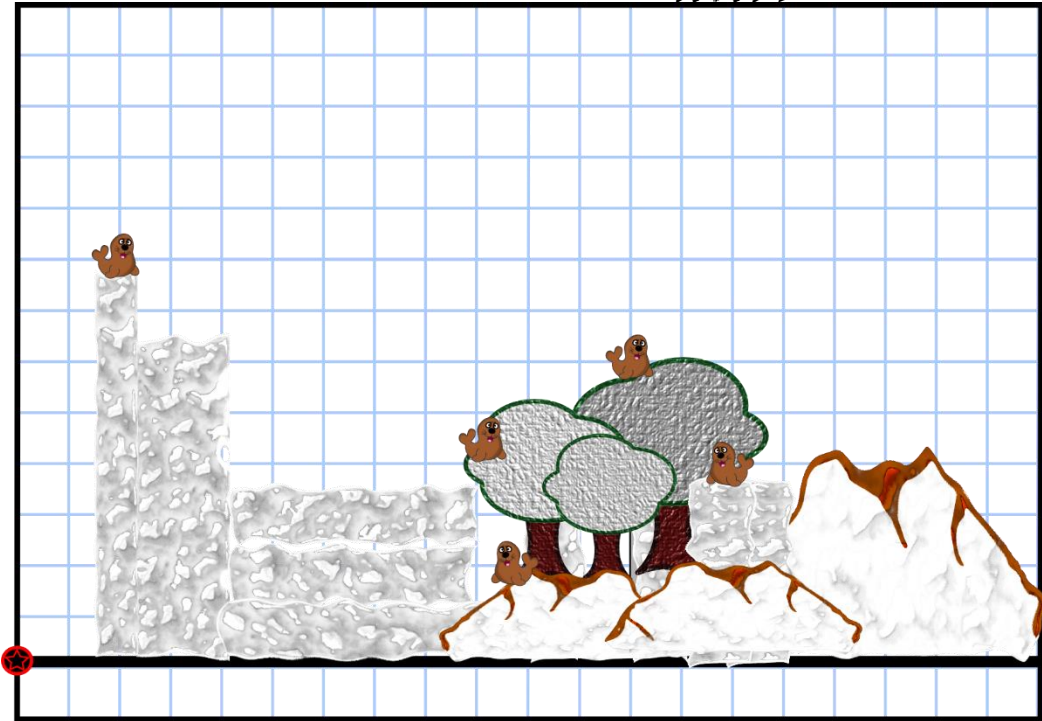
Use the cutouts to determine which paths will pass through the seals. One endpoint of the parabola must start on the star. Record the successful equations in the tables.

- LEVEL 1 -



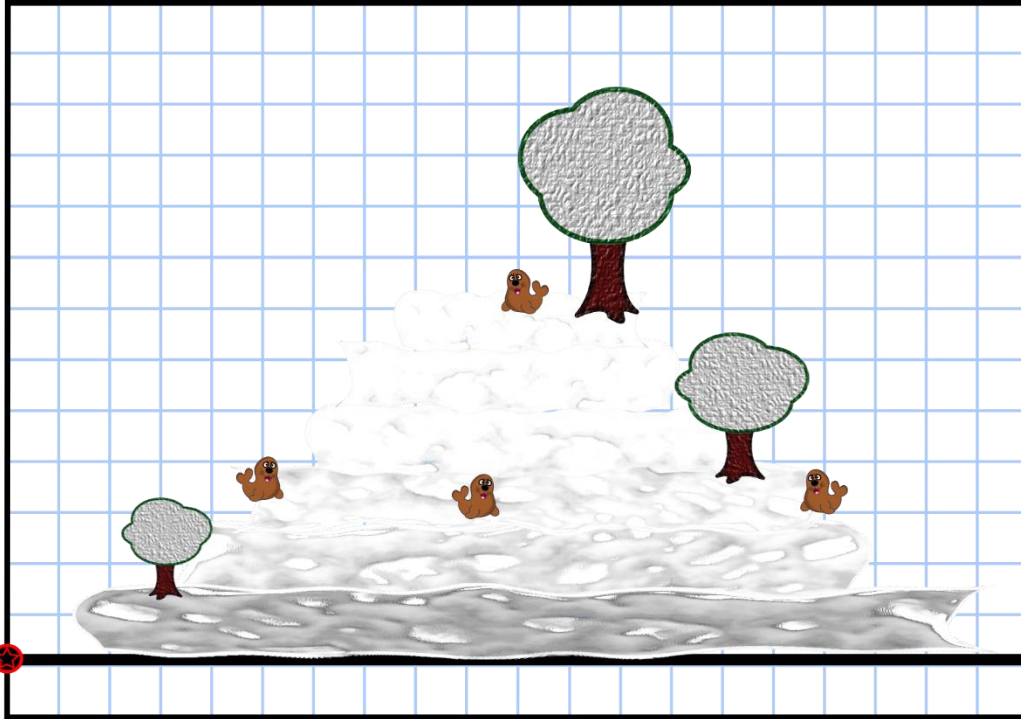
EQUATION	SEALS POOFED
1.	
2.	

- LEVEL 2 -



EQUATION	SEALS POOFED
1.	
2.	

- LEVEL 3 -

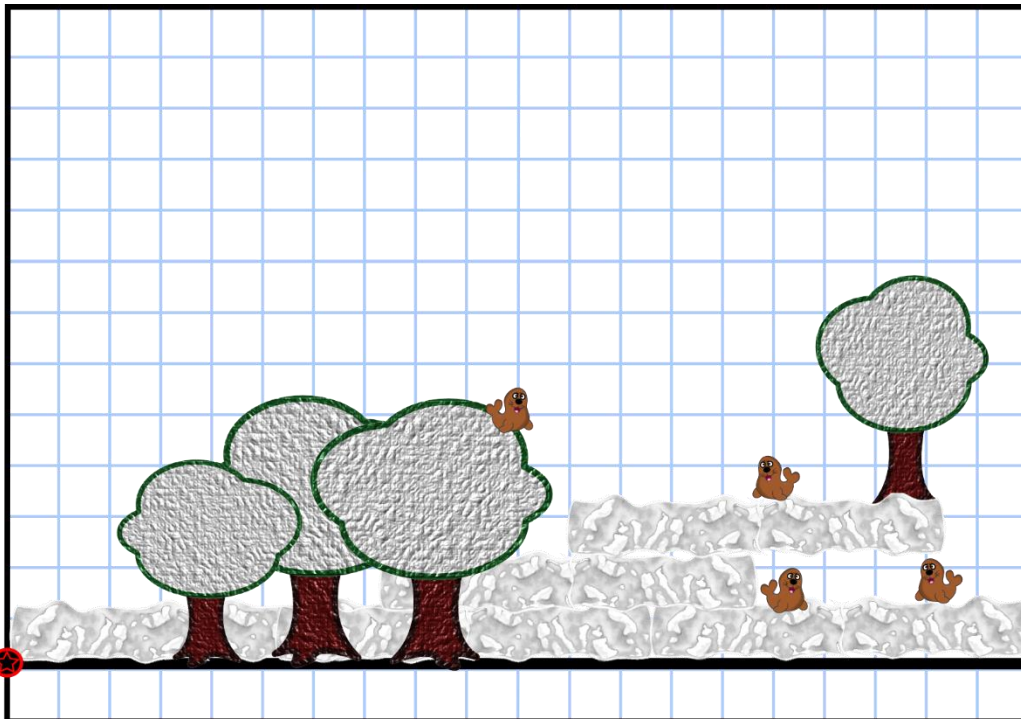


EQUATION

**SEALS
POOFED**

1.	
2.	
3.	

- LEVEL 4 -



EQUATION

**SEALS
POOFED**

1.	
2.	
3.	



LAUNCH PATH REFERENCE SHEET

Highlighted cells have integer coordinates and are marked on the parabolas



	PATH A	PATH B	PATH C	PATH D
X	$y = 5x - \frac{x^2}{2}$	$y = 3x - \frac{x^2}{4}$	$y = 2x - \frac{x^2}{8}$	$y = x - \frac{x^2}{20}$
0	0	0	0	0
1	4.5	2.75	1.875	0.95
2	8	5	3.5	1.8
3	10.5	6.75	4.875	2.55
4	12	8	6	3.2
5	12.5	8.75	6.875	3.75
6	12	9	7.5	4.2
7	10.5	8.75	7.875	4.55
8	8	8	8	4.8
9	4.5	6.75	7.875	4.95
10	0	5	7.5	5
11		2.75	6.875	4.95
12		0	6	4.8
13			4.875	4.55
14			3.5	4.2
15			1.875	3.75
16			0	3.2
17				2.55
18				1.8
19				0.95
20				0



LAUNCH PATH ANALYSIS



Using the reference sheet, answer the following equations.

1. How far will a Penguin travel horizontally in each of the paths?

A	
B	
C	
D	

2. What is the difference between the longest horizontal distance and the shortest?

3. What is the maximum height of each path and when does it occur? (What is the vertex of the parabola?)

	MAXIMUM HEIGHT	VERTEX OF THE PARABOLA
A		
B		
C		
D		

4. If “Power-Ups” can only be activated when the path is at a point with integer coordinates (not counting (0,0)), how many times and at what points can each path have a Power-Up activated?

	HOW MANY INTEGER COORDINATES?	WHAT POINT(S)?
A		
B		
C		
D		

HUNTER PENGUIN



LINEAR

$$y = -\frac{1}{4}(x - h) + k$$

Where (h,k) is the deployment point.

NEW RECRUITS

(CUT OUT TO USE -- THEY ARE TO SCALE)

$$y = -\frac{1}{4}x$$

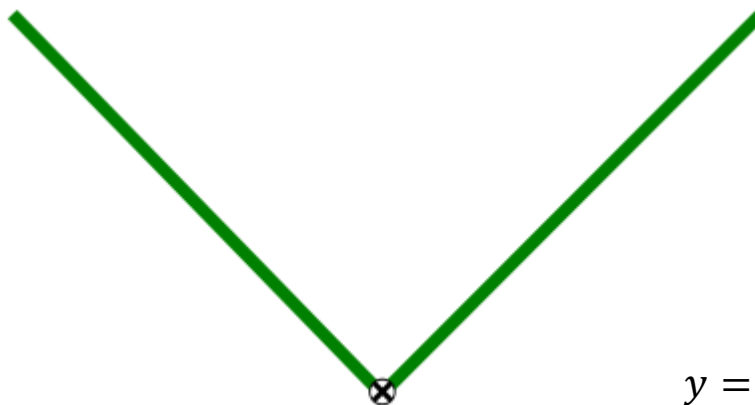
SURGEON PENGUIN



ABSOLUTE VALUE

$$y = |x - h| + k$$

Where (h,k) is the deployment point.



$$y = |x|$$

PIRATE PENGUIN

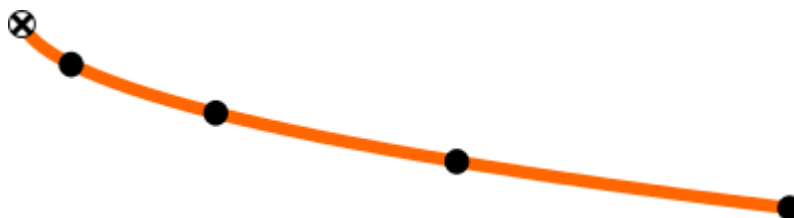


SQUARE ROOT

$$y = -\sqrt{x - h} + k$$

Where (h,k) is the deployment point.

$$y = -\sqrt{x}$$



WIZARD PENGUIN



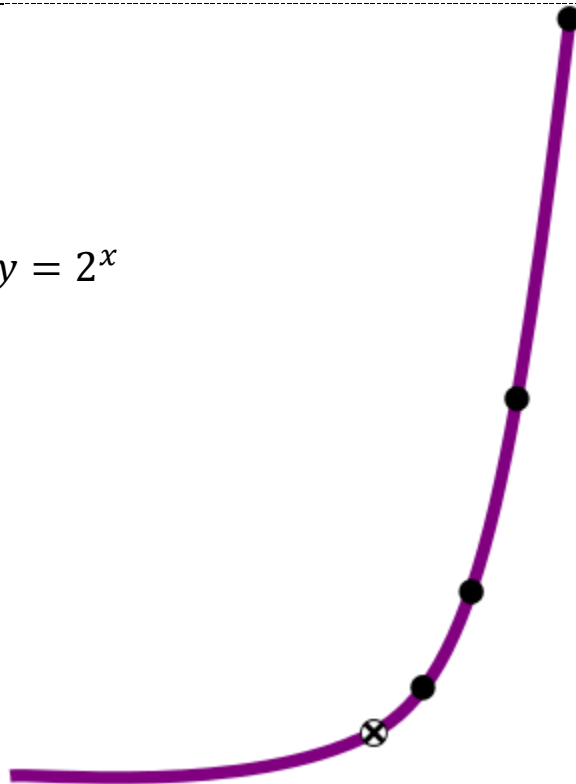
EXPONENTIAL

$$y = 2^{(x-h)} + k - 1$$

Where (h,k) is the deployment point.

**Please Note: the additional subtraction of 1

$$y = 2^x$$



PILOT PENGUIN

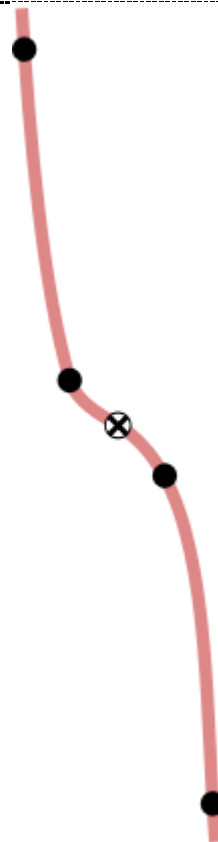


CUBIC

$$y = -(x - h)^3 + k$$

Where (h,k) is the deployment point.

$$y = -x^3$$

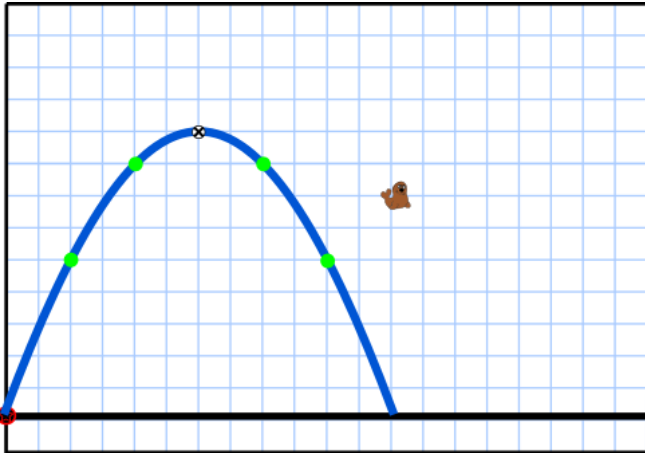




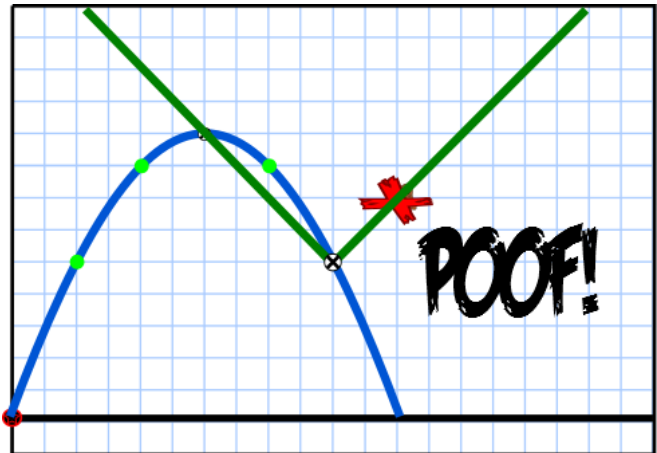
PIECEWISE POWER-UP

What fun is throwing birds if you cannot activate a super power in the middle of the path? While Kung Fu Penguin is limited with only the parabolic path, there are five friends who can help “Poof some Seals” previously out of reach.

The game works the same. One of the four parabolic paths will be chosen, but now those nice integer coordinates will come into play. After being launched, a Powered-Up Penguin at an integer coordinate (marked with the colored circles) can activate their power. By using the cutouts of the “New Recruits” you will be able to match the X of the function, with the location of the power activation. See the destruction below.



You must think you are a slick Seal because you positioned yourself slightly out of range



Booyah, Seal. Booyah.

In order to pull this off mathematically, this has become a *Piecewise Function* and it will need to be defined as such. A Piecewise Function is a function that is defined with at least two sub-functions. Points where the functions change become critical points in the intervals. In the case of all Penguins, these critical points must all be continuous. Thus, where the first function (the quadratic function) ends, the next function (the Power-Up) must begin. Use the general function definition on the “New Recruits” to help write these functions. Notice the critical point of the function above occurred at (10, 5)

In this case, Path B ($y = 3x - \frac{x^2}{4}$) was used and the piecewise function should look like this...

$$f(x) = \begin{cases} 3x - \frac{x^2}{4} & \text{if } 0 \leq x < 10 \\ |x - 10| + 5 & \text{if } x \geq 10 \end{cases}$$

Essentially you are writing a function transformation of the Power-Up function. The only rule is that the “X” written on the Power-Up function, must be transformed to an integer coordinate of the parabolic path. The general functions should be helpful with this.

So now I ask... are you ready to Power-Up Poof some Seals?

Name _____

Date _____

Period _____

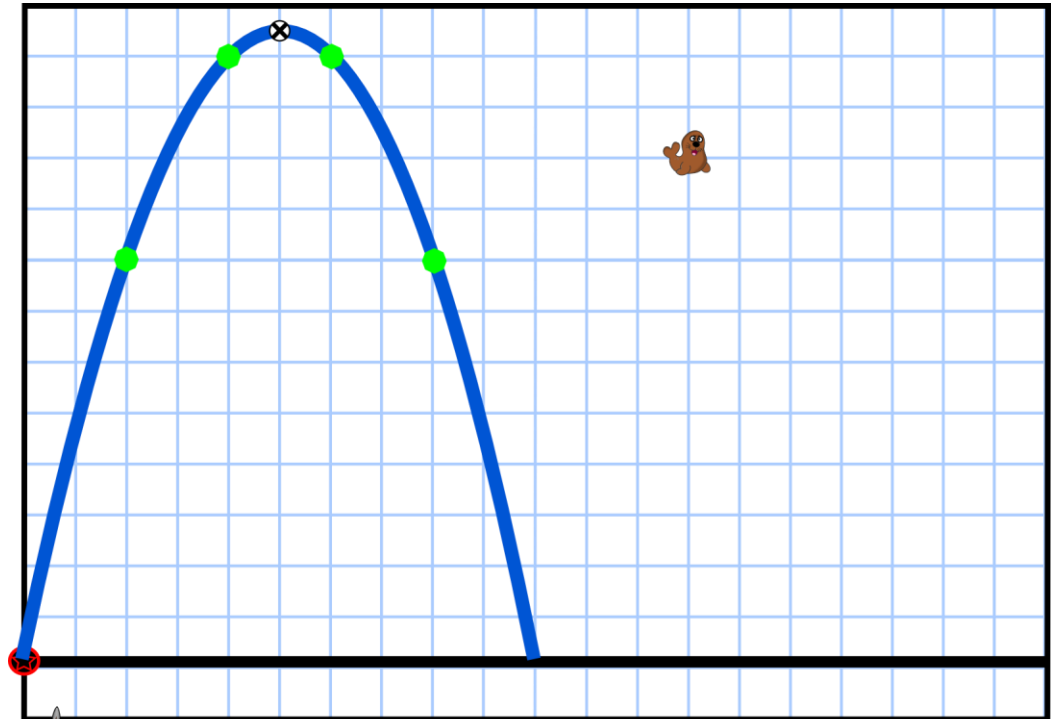
Use the cutouts from the *Launch Path & New Recruits* handouts.
Sketch the functions on the graph and write piecewise functions of the result.

- EXERCISE 1 -

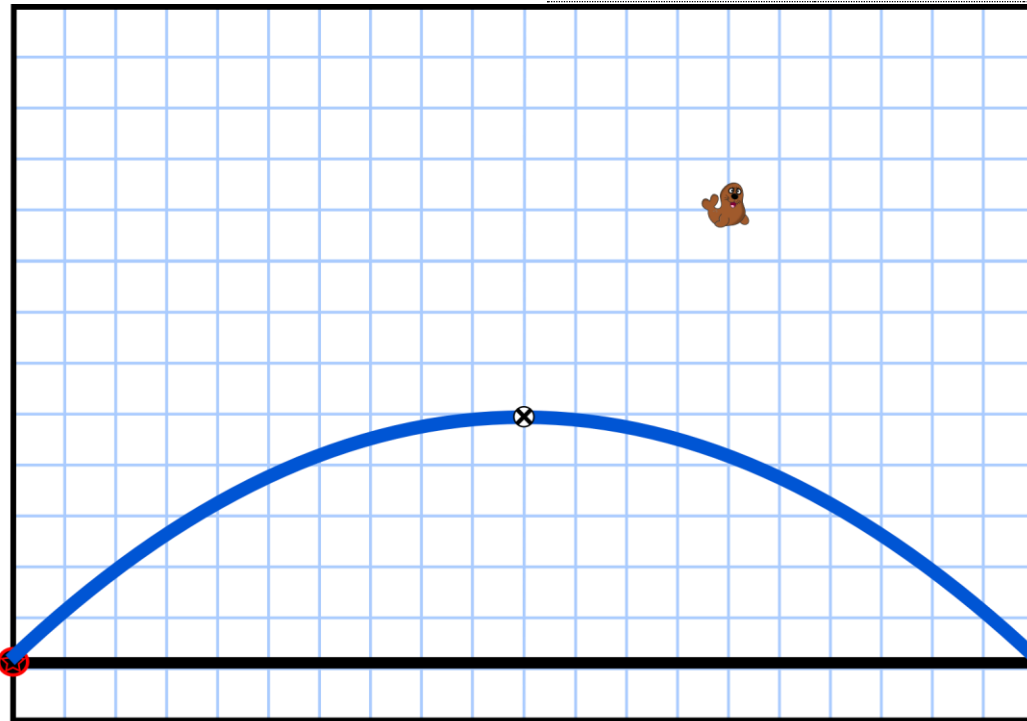
i. Which Penguin is being used in this exercise?

ii. What is the general equation of that penguin?

iii. At what point will the penguin use its power-up?



$f(x) = \left\{ \begin{array}{l} \end{array} \right.$	$5x - \frac{x^2}{2}$	if	$0 \leq x <$
		if	$x \geq$



- EXERCISE 2 -

i. Which Penguin is being used in this exercise?

ii. What is the general equation of that penguin?

iii. At what point will the penguin use its power-up?



$f(x) = \left\{ \begin{array}{l} \end{array} \right.$	$x - \frac{x^2}{20}$	if	$0 \leq x <$

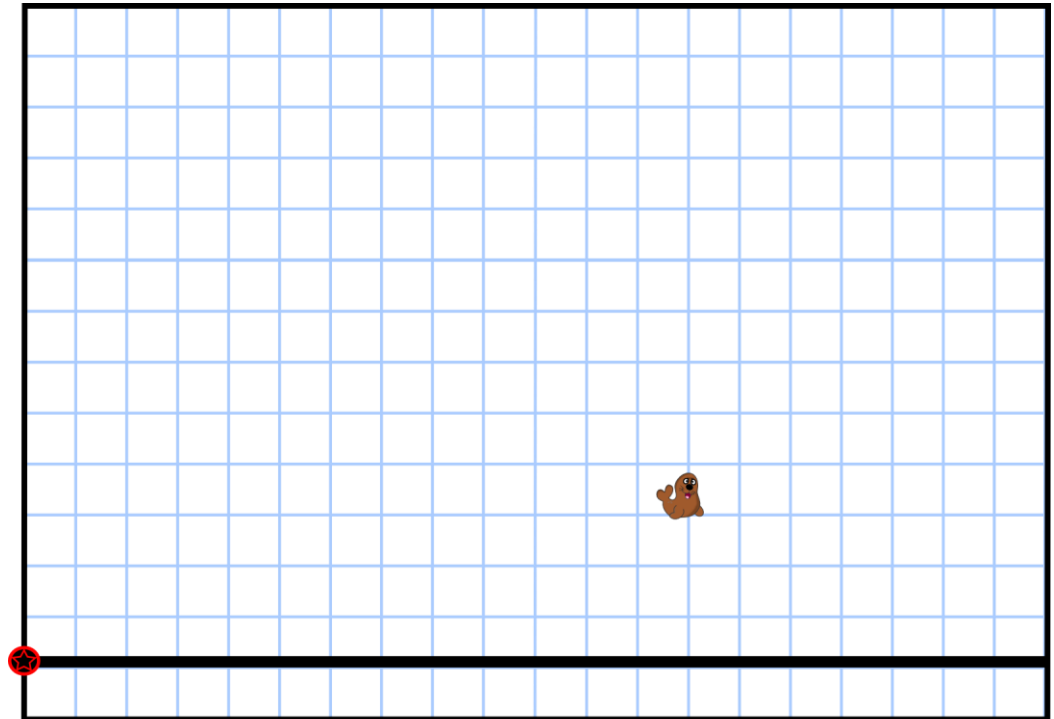
Use the cutouts from the *Launch Path & New Recruits* handouts.
Sketch the functions on the graph and write piecewise functions of the result.

- EXERCISE 3 -

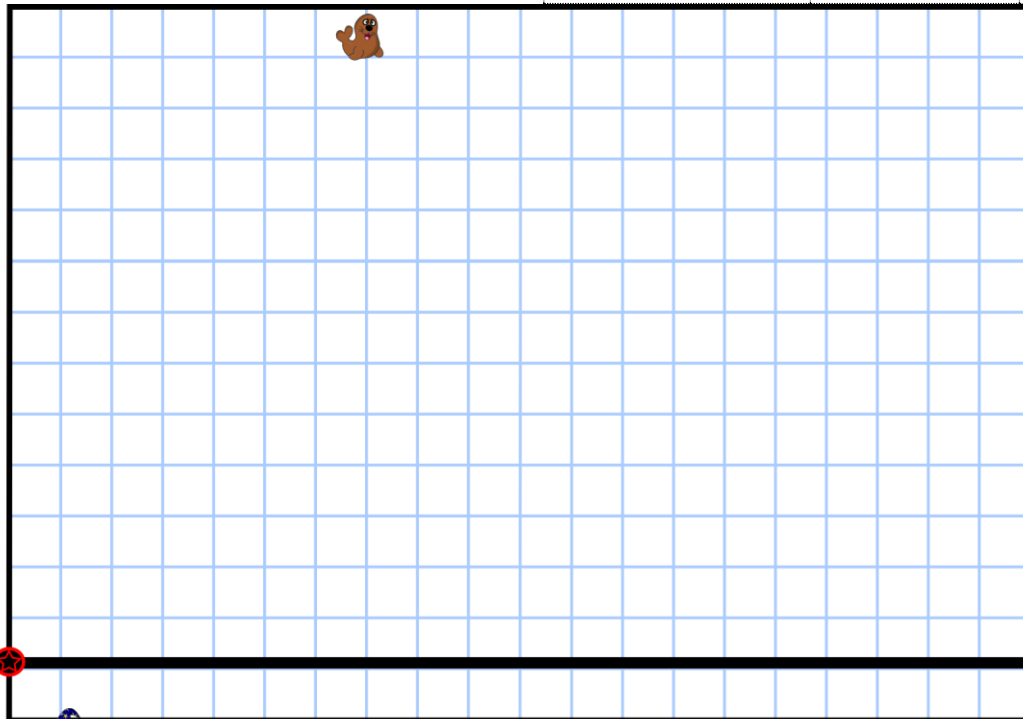
i. Which Penguin is being used in this exercise?

ii. What is the general equation of that penguin?

iii. At what point will the penguin use its power-up?



$$f(x) = \{$$



- EXERCISE 4 -

i. Which Penguin is being used in this exercise?

ii. What is the general equation of that penguin?

iii. At what point will the penguin use its power-up?



$$f(x) = \{$$

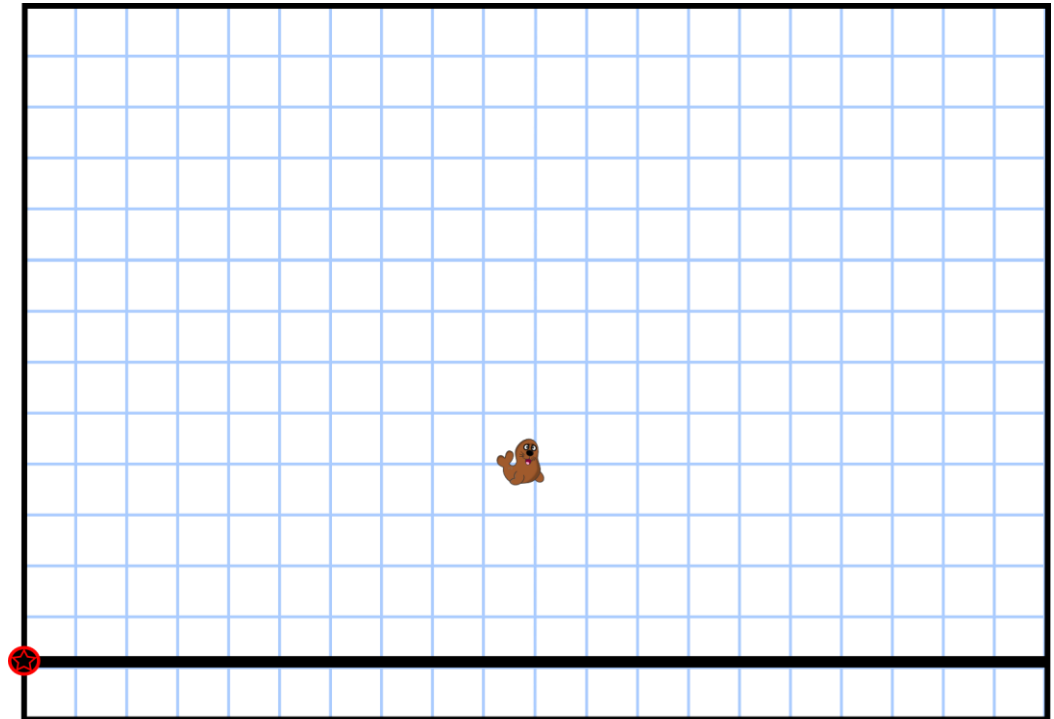
Use the cutouts from the *Launch Path & New Recruits* handouts.
Sketch the functions on the graph and write piecewise functions of the result.

- EXERCISE 5 -

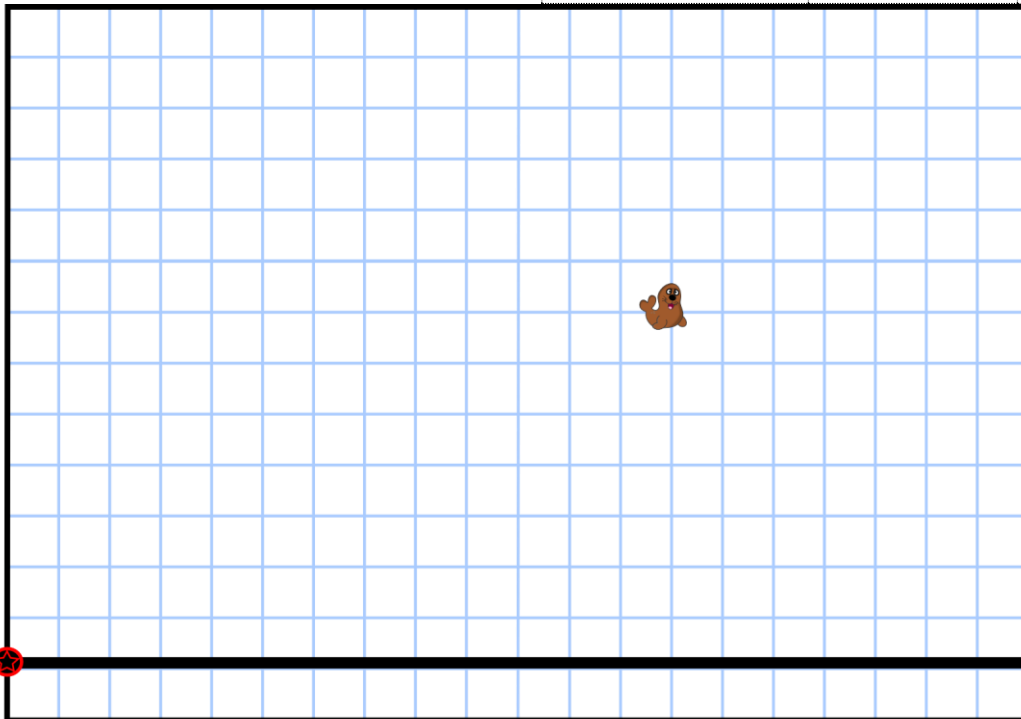
i. Which Penguin is being used in this exercise?

ii. What is the general equation of that penguin?

iii. At what point will the penguin use its power-up?



$$f(x) = \left\{ \begin{array}{l} \\ \\ \end{array} \right.$$



- EXERCISE 6 -

i. Which Penguin will you use in this exercise?

ii. What is the general equation of that penguin?

iii. At what point will the penguin use its power-up?

PICK YOUR OWN PENGUIN

$f(x) = \left\{ \begin{array}{l} \\ \\ \end{array} \right.$		if	$0 \leq x <$
		if	$x \geq$

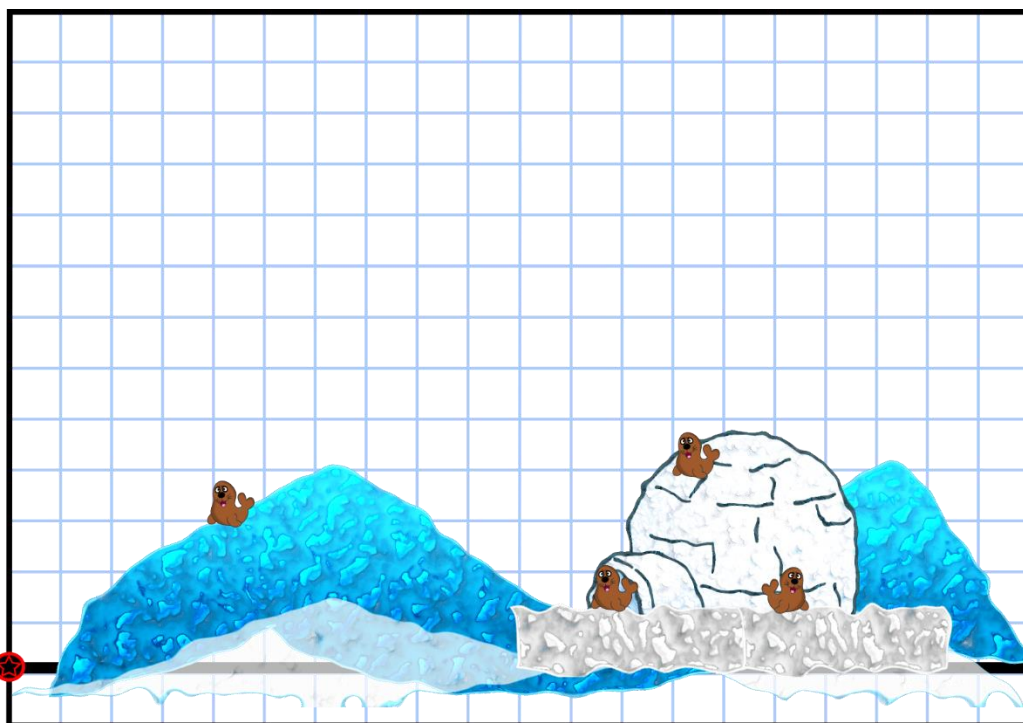
ANGRY PENGUINS



It's time to put all the skills to use. Bird tossing will never be more fun than in a mega-super-exclusive version of everyone's favorite Piecewise Function game *Angry Penguins*. Players will be given a limited supply of Penguins for each round. The player will select one of four parabolic paths to launch a penguin. If the penguin has a Power-Up, it can be activated on points with integer coordinates. If a line of a path intersects a Seal, the Seal is "poofed". The object of each level is to "Poof" all of the Seals. If you have Penguins left over on each level, you will receive a bonus!

On each level, you will need to sketch the path of each function that you are using. Use the cutouts provided in *Launch Paths* and *New Recruits* to decide what choices to make. After you have chosen a path, you will need to record it as a single function or a piecewise function in the table provided. What are you waiting for? Go poof those Seals!

- LEVEL 1: THE IGLOO -



PENGUIN



EQUATION

SEALS POOFED

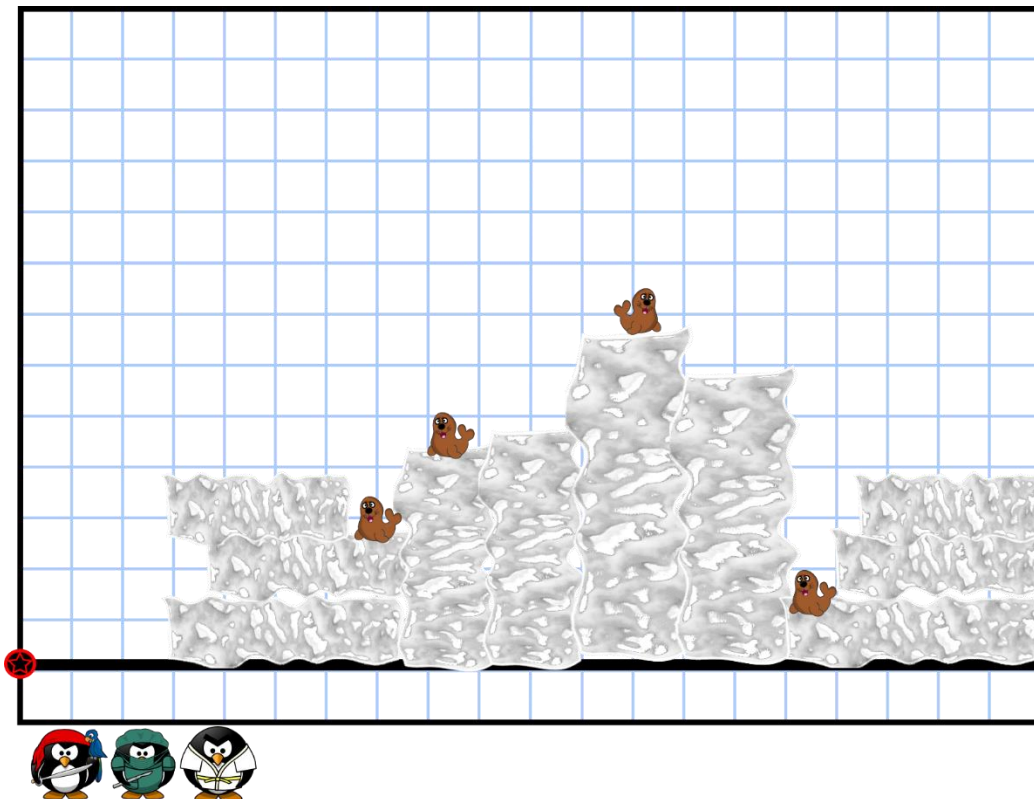
1. Kung Fu		
2. Pilot		

Name _____

Date _____

Period _____

- LEVEL 2: THE GLACIAL MASS -



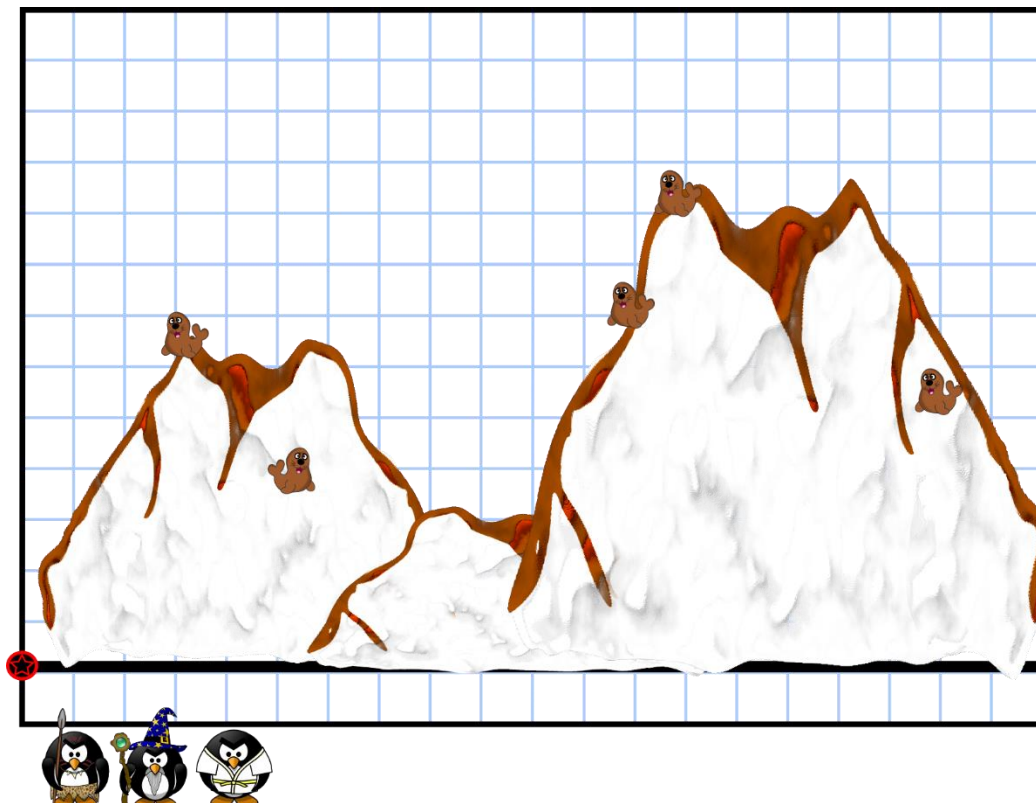
PENGUIN

EQUATION

SEALS POOFED

1.		
2.		
3.		

- LEVEL 3: THE TALL MOUNTAIN LEVEL -



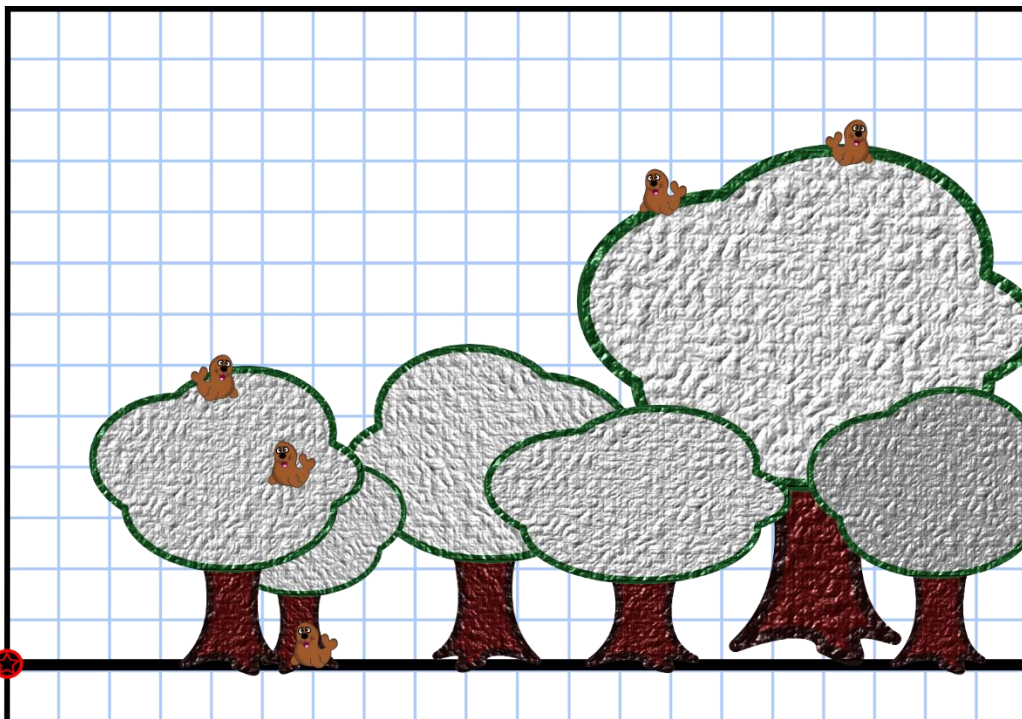
PENGUIN

EQUATION

SEALS POOFED

1.		
2.		
3.		

- LEVEL 4: PETRIFIED FOREST -



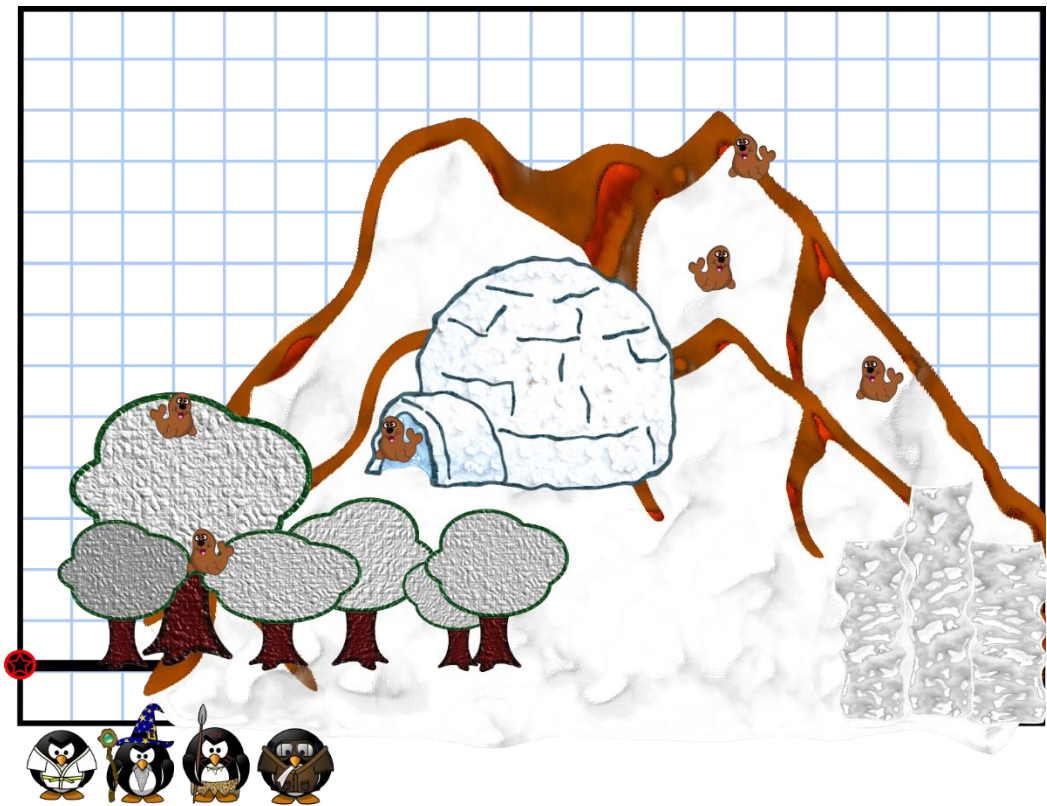
PENGUIN

EQUATION

SEALS POOFED

1.		
2.		
3.		
4.		

- LEVEL 5: THE LEVEL THAT COMBINES ALL OTHER LEVELS-



PENGUIN

EQUATION

SEALS POOFED

1.		
2.		
3.		
4.		



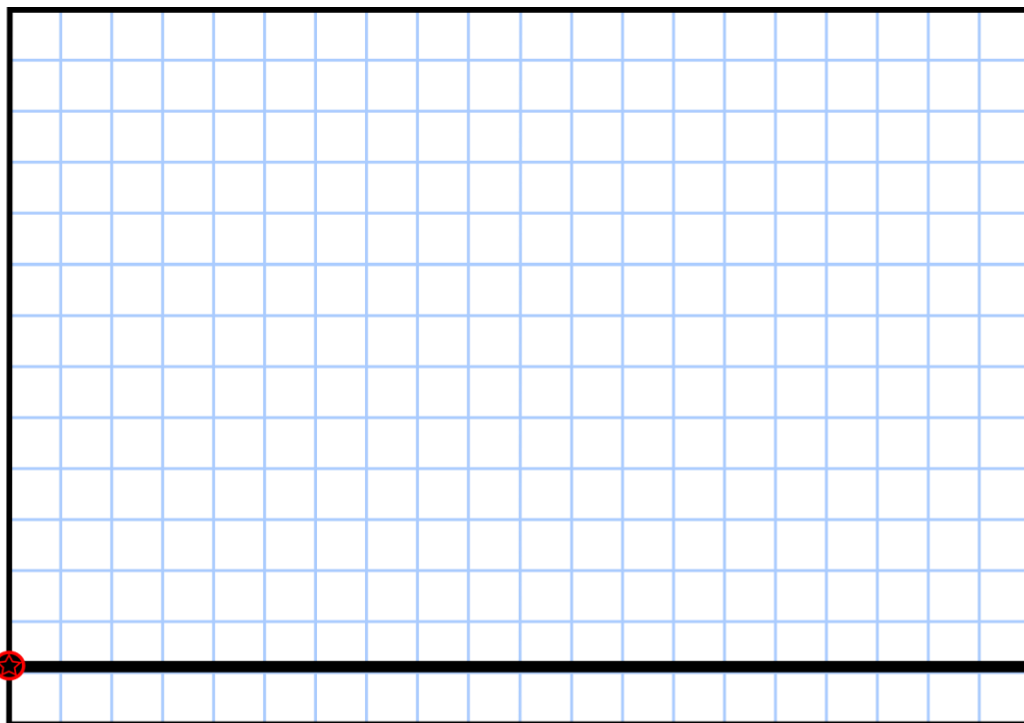
BUILD-YOUR-OWN

ANGRY PENGUINS LEVEL

Now that you have passed the greatest test of your life, it is time for you to become the test maker. In this assignment your task is to construct your own *Angry Penguins* level. It will likely be used in the sequel: *Angry Penguins: Star Wars Jedi Penguin Edition*.

In your level you must include: at least four seals, at least three Penguins, a *piecewise function* and a solution

LEVEL TITLE: _____



PENGUIN

EQUATION

SEALS POOFED

1.		
2.		
3.		
4.		

Name _____

Date _____

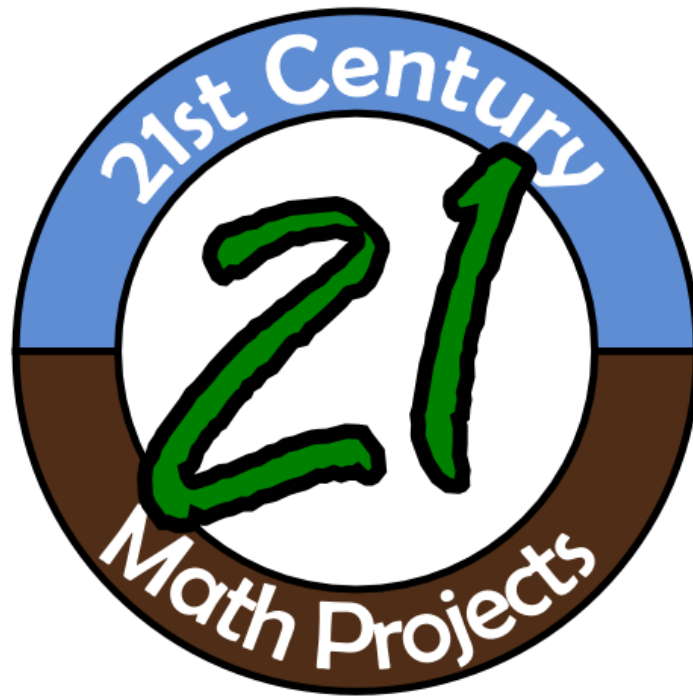
Period _____

Thank you for being my Math Friend!

If you liked this

21st Century Math Project

You might like others. (Click the logo)



Math it Up.

Boondigggy.

PARABOLIC DESTRUCTION

In American culture people have an affinity for launching birds, pheasants and other sorts of fowl at oblivious targets with a sling shot. Where does this fascination come from? Nobody knows. Nonetheless, it makes for an interesting quadratic function application. Are you ready to help out costumed Penguins extract centuries of revenge against those slap-happy menacing predators -- the Seals. Of course you are.

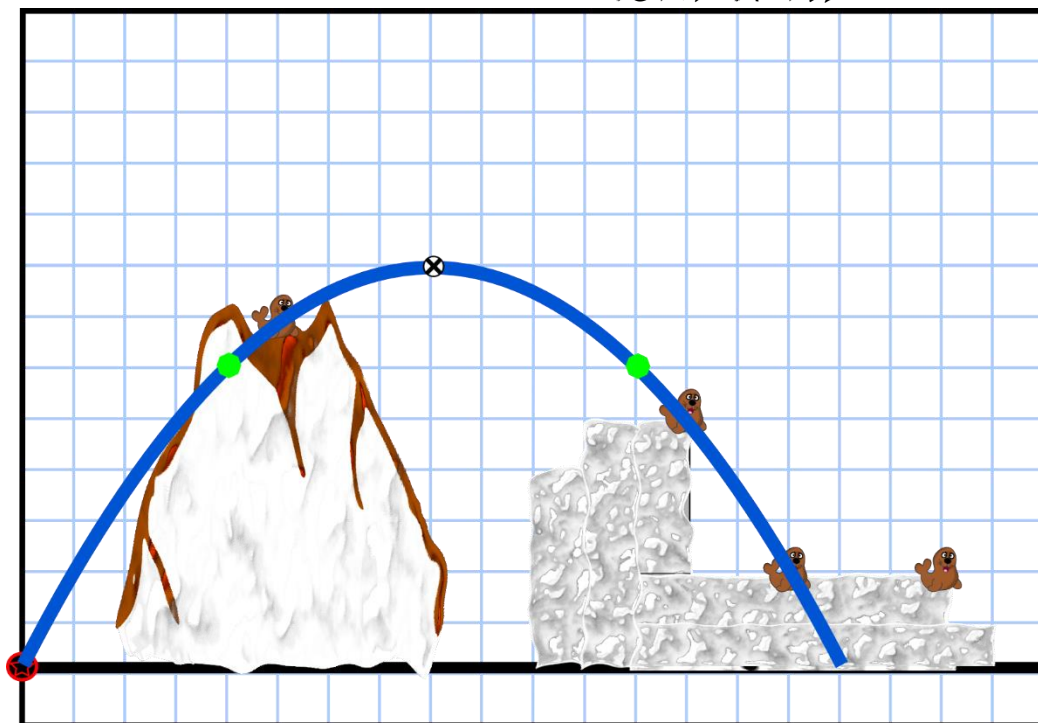


Cut out the four "Launch Paths". These will be needed throughout this entire project. To launch a Penguin, you will select one of the four launch paths. Each time the parabola crosses a Seal, the Seal goes "poof". You can mark each poofed Seal with a very small X. The object of the game is to make all of the Seals on the board go "poof".

Under each game board you will find which penguin you can use. Only the Kung Fu Penguin will be used at this point, but other penguins will be introduced later. After each Penguin is launched, you must record the equation of their trajectory. All penguins will pass through any obstacles on their path.

ANSWER KEY

- FOR EXAMPLE -



EQUATION

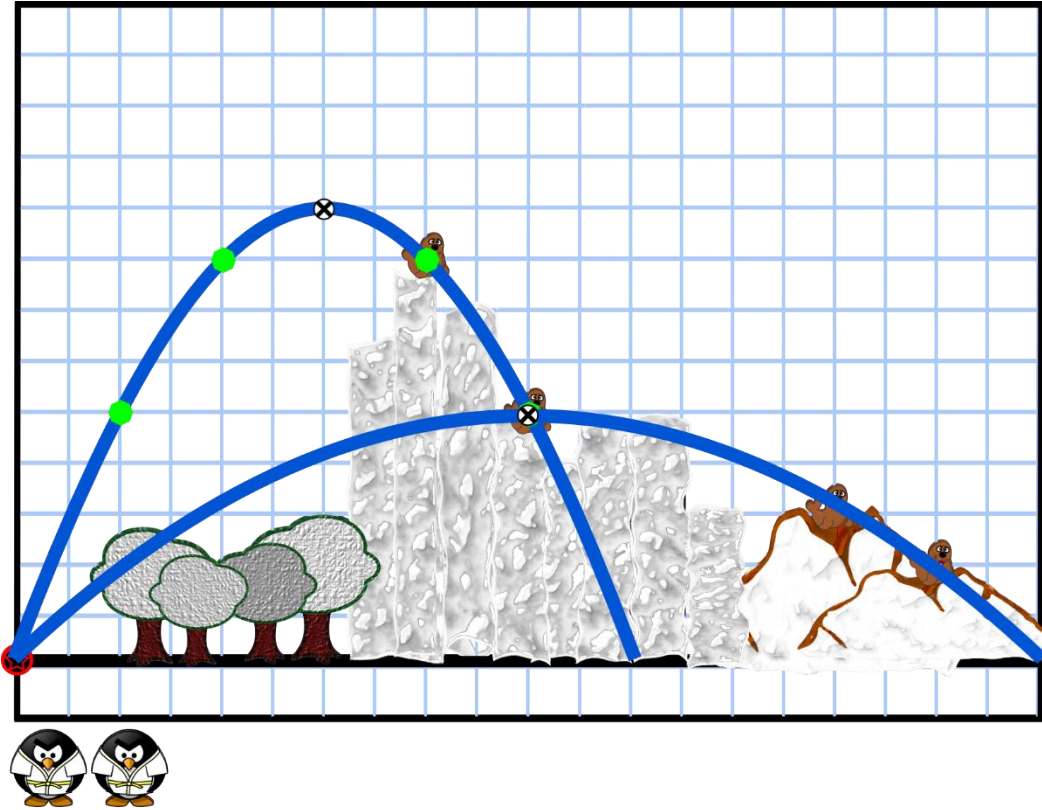
**SEALS
POOFED**

1.	$y = 2x - \frac{x^2}{8}$	3
2.		
3.		

In this example, there are three Kung Fu Penguins that you can use. The first Penguin was launched with at Path C ($y = 2x - \frac{x^2}{8}$) and it poofed three Seals. One Seal remains for the next round and the player would have to figure out a combination that will make them Poof.

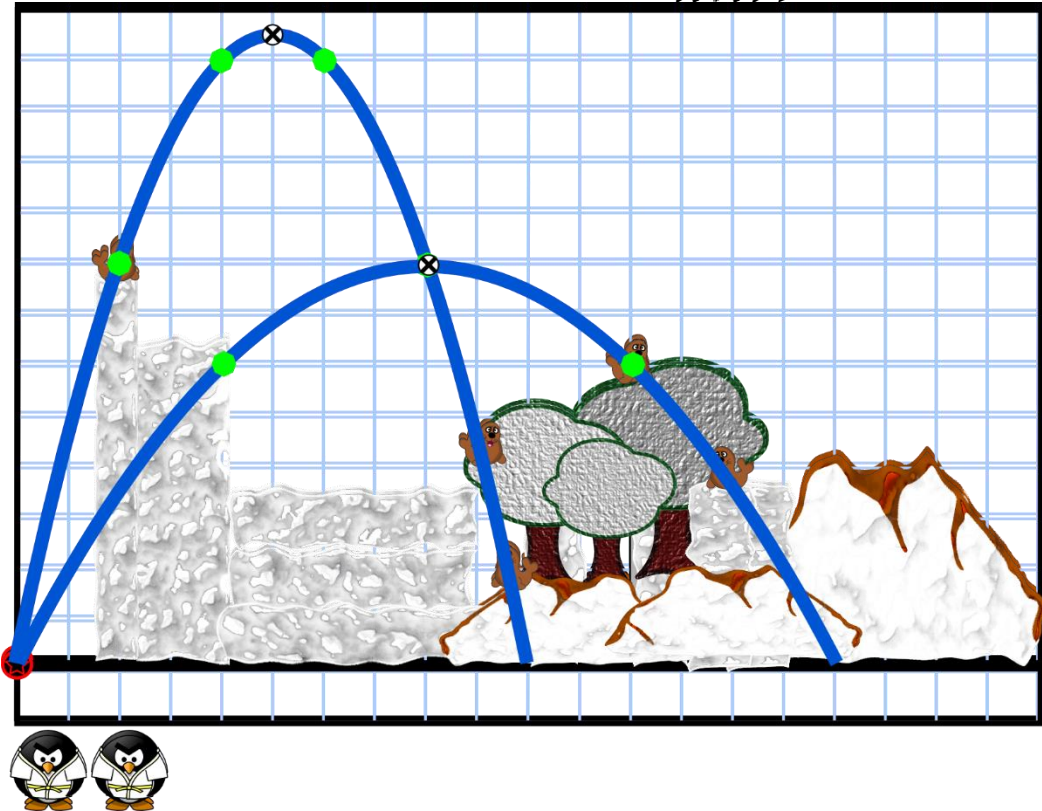
Use the cutouts to determine which paths will pass through the seals. One endpoint of the parabola must start on the star. Record the successful equations in the tables.

- LEVEL 1 -



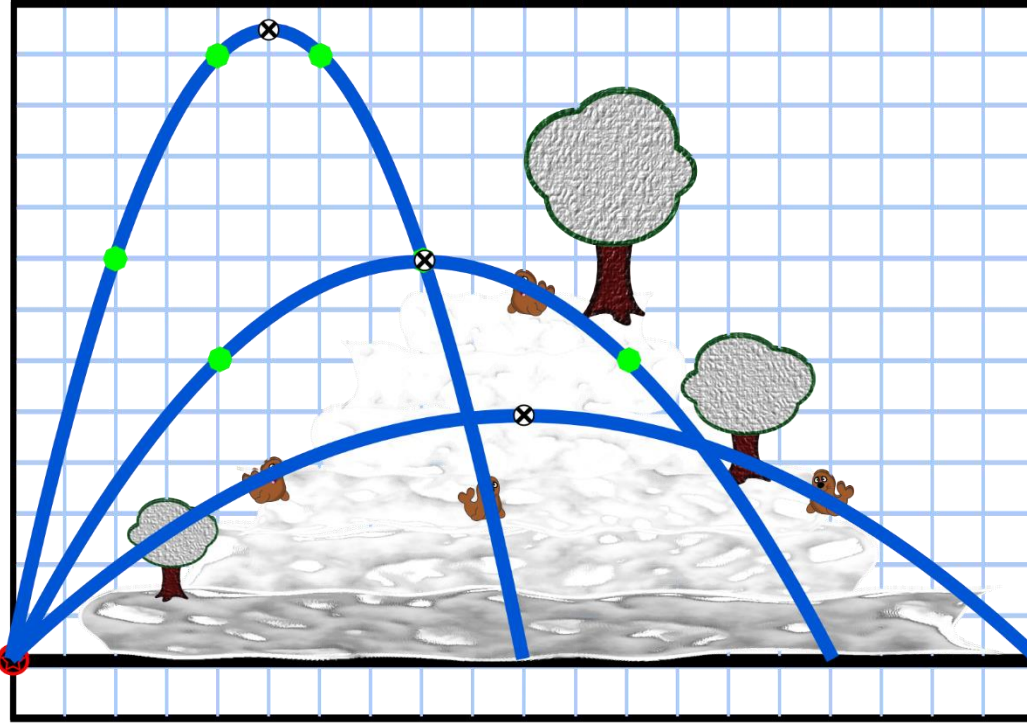
EQUATION	SEALS POOFED
1. $3x - \frac{x^2}{4}$	2
2. $x - \frac{x^2}{20}$	2

- LEVEL 2 -



EQUATION	SEALS POOFED
1. $5x - \frac{x^2}{2}$	3
2. $2x - \frac{x^2}{8}$	2

- LEVEL 3 -

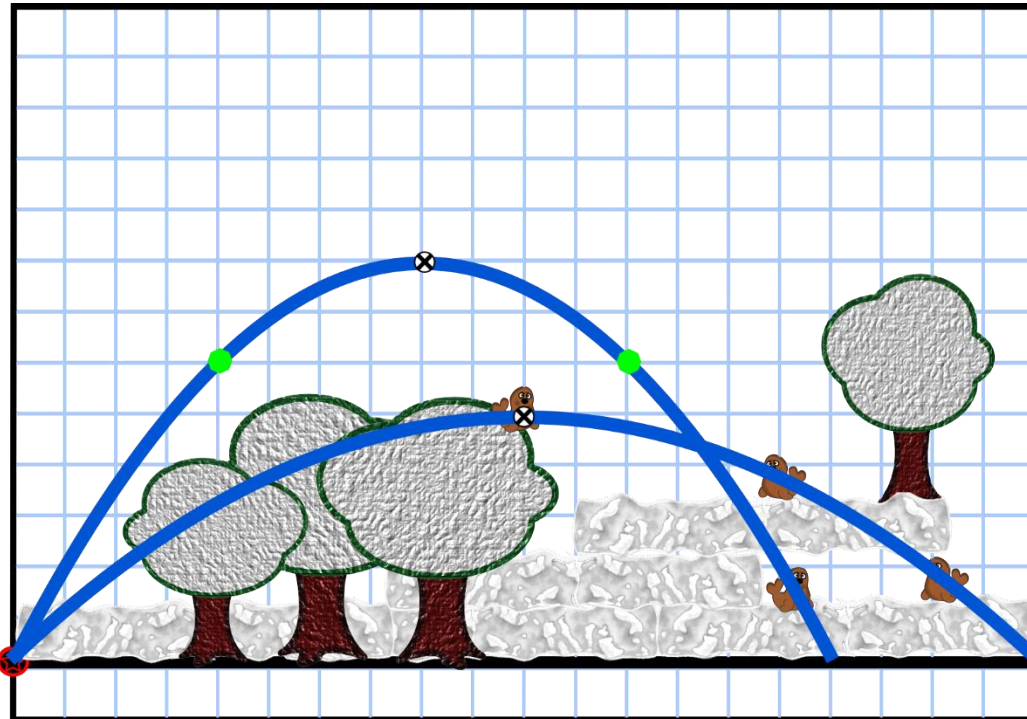


EQUATION

SEALS
POOFED

1.	$5x - \frac{x^2}{2}$	1
2.	$2x - \frac{x^2}{8}$	1
3.	$x - \frac{x^2}{20}$	2

- LEVEL 4 -



EQUATION

SEALS
POOFED

1.	$x - \frac{x^2}{20}$	3
2.	$2x - \frac{x^2}{8}$	1
3.		



LAUNCH PATH ANALYSIS



Using the reference sheet, answer the following equations.

1. How far will a Penguin travel horizontally in each of the paths?

A	10
B	12
C	16
D	20

2. What is the difference between the longest horizontal distance and the shortest?

10 units

3. What is the maximum height of each path and when does it occur? (What is the vertex of the parabola?)

	MAXIMUM HEIGHT	VERTEX OF THE PARABOLA
A	12.5	(5, 12.5)
B	9	(6, 9)
C	8	(8, 8)
D	5	(10, 5)

4. If “Power-Ups” can only be activated when the path is at a point with integer coordinates (not counting (0,0)), how many times and at what points can each path have a Power-Up activated?

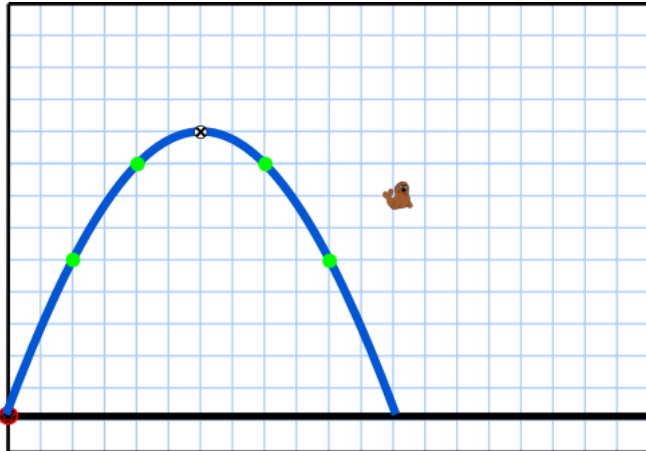
	HOW MANY INTEGER COORDINATES?	WHAT POINT(S)?
A	4	(2,8), (4, 12), (6, 12), (8, 8)
B	5	(2,5), (4, 8), (6,9) (8,8), (10,5)
C	3	(4,6), (8, 8), (12,6)
D	1	(10,5)



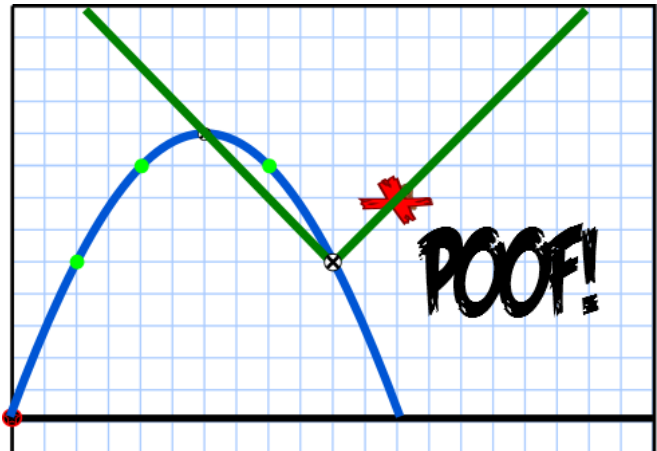
PIECEWISE POWER-UP

What fun is throwing birds if you cannot activate a super power in the middle of the path? While Kung Fu Penguin is limited with only the parabolic path, there are five friends who can help “Poof some Seals” previously out of reach.

The game works the same. One of the four parabolic paths will be chosen, but now those nice integer coordinates will come into play. After being launched, a Powered-Up Penguin at an integer coordinate (marked with the colored circles) can activate their power. By using the cutouts of the “New Recruits” you will be able to match the X of the function, with the location of the power activation. See the destruction below.



You must think you are a slick Seal because you positioned yourself slightly out of range



Booyah, Seal. Booyah.

In order to pull this off mathematically, this has become a *Piecewise Function* and it will need to be defined as such. A Piecewise Function is a function that is defined with at least two sub-functions. Points where the functions change become critical points in the intervals. In the case of all Penguins, these critical points must all be continuous. Thus, where the first function (the quadratic function) ends, the next function (the Power-Up) must begin. Use the general function definition on the “New Recruits” to help write these functions. Notice the critical point of the function above occurred at (10, 5)

In this case, Path B ($y = 3x - \frac{x^2}{4}$) was used and the piecewise function should look like this...

$$f(x) = \begin{cases} 3x - \frac{x^2}{4} & \text{if } 0 \leq x < 10 \\ |x - 10| + 5 & \text{if } x \geq 10 \end{cases}$$

Essentially you are writing a function transformation of the Power-Up function. The only rule is that the “X” written on the Power-Up function, must be transformed to an integer coordinate of the parabolic path. The general functions should be helpful with this.

So now I ask... are you ready to Power-Up Poof some Seals?

Use the cutouts from the *Launch Path* & *New Recruits* handouts.
Sketch the functions on the graph and write piecewise functions of the result.

- EXERCISE 1 -

i. Which Penguin is being used in this exercise?

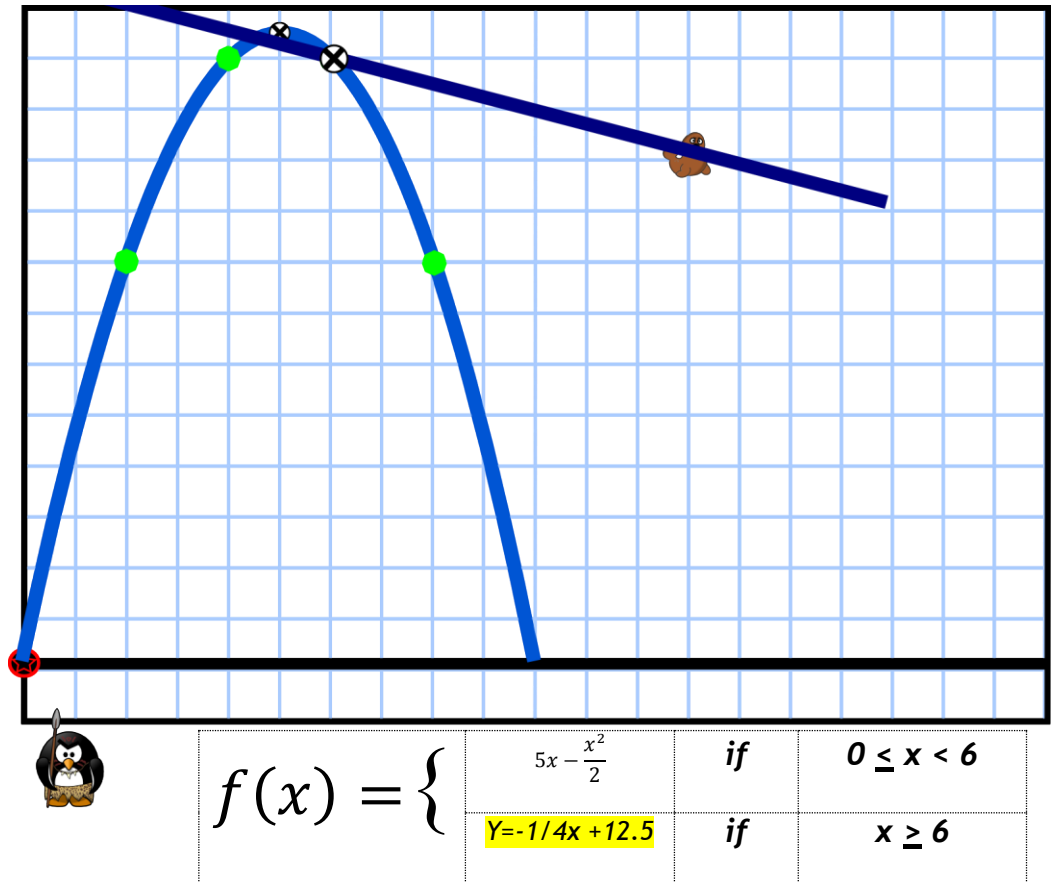
Hunter Penguin

ii. What is the general equation of that penguin?

$$Y = -\frac{1}{4}(x - h) + k$$

iii. At what point will the penguin use its power-up?

(6, 12)



- EXERCISE 2 -

i. Which Penguin is being used in this exercise?

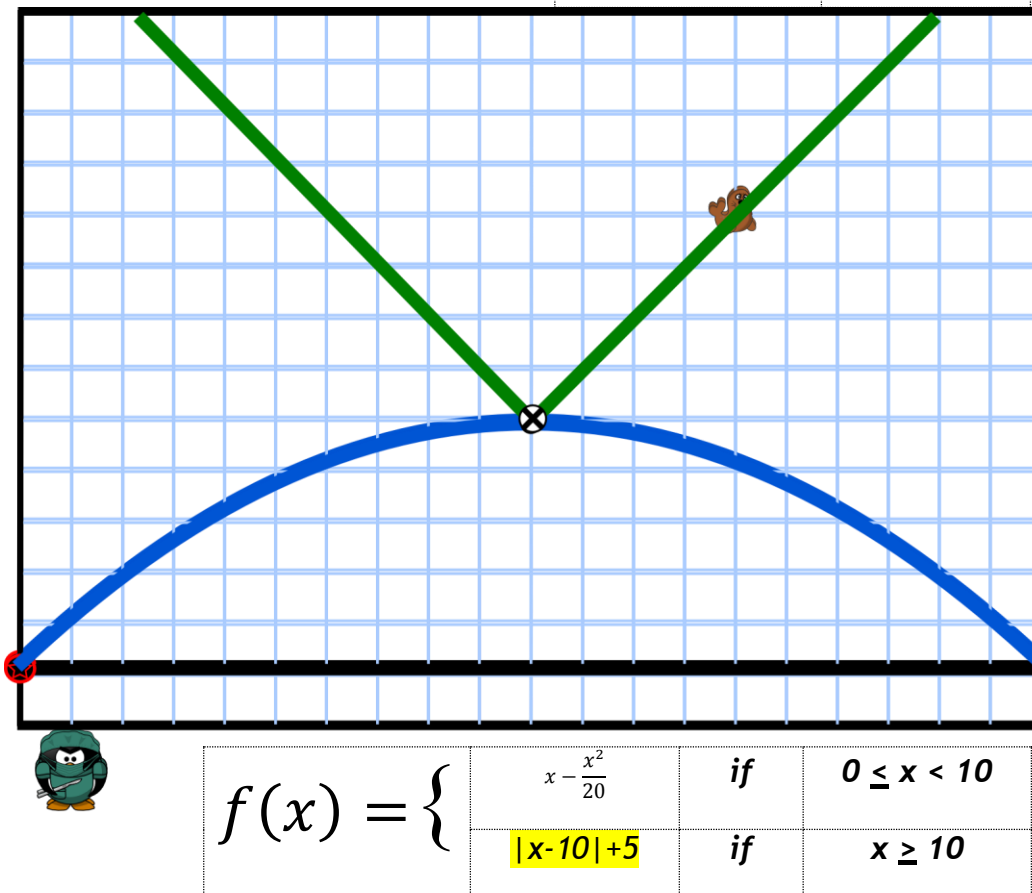
Surgeon Penguin

ii. What is the general equation of that penguin?

$$y = |x - h| + k$$

iii. At what point will the penguin use its power-up?

(10,5)



Use the cutouts from the *Launch Path & New Recruits* handouts.
Sketch the functions on the graph and write piecewise functions of the result.

- EXERCISE 3 -

i. Which Penguin is being used in this exercise?

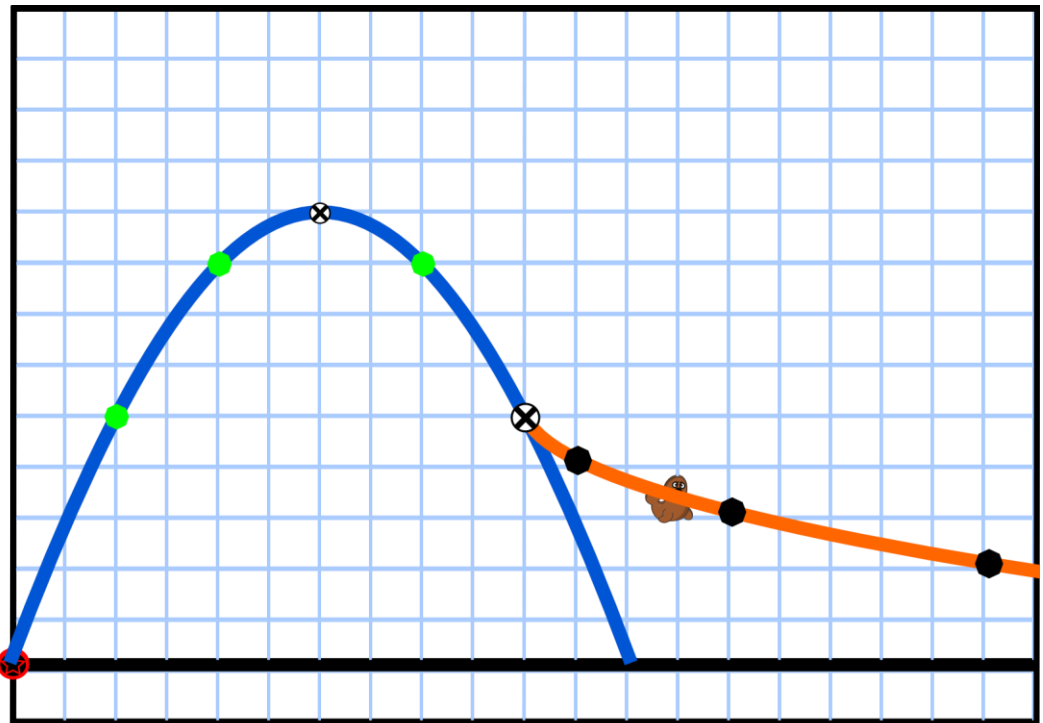
Pirate Penguin

ii. What is the general equation of that penguin?

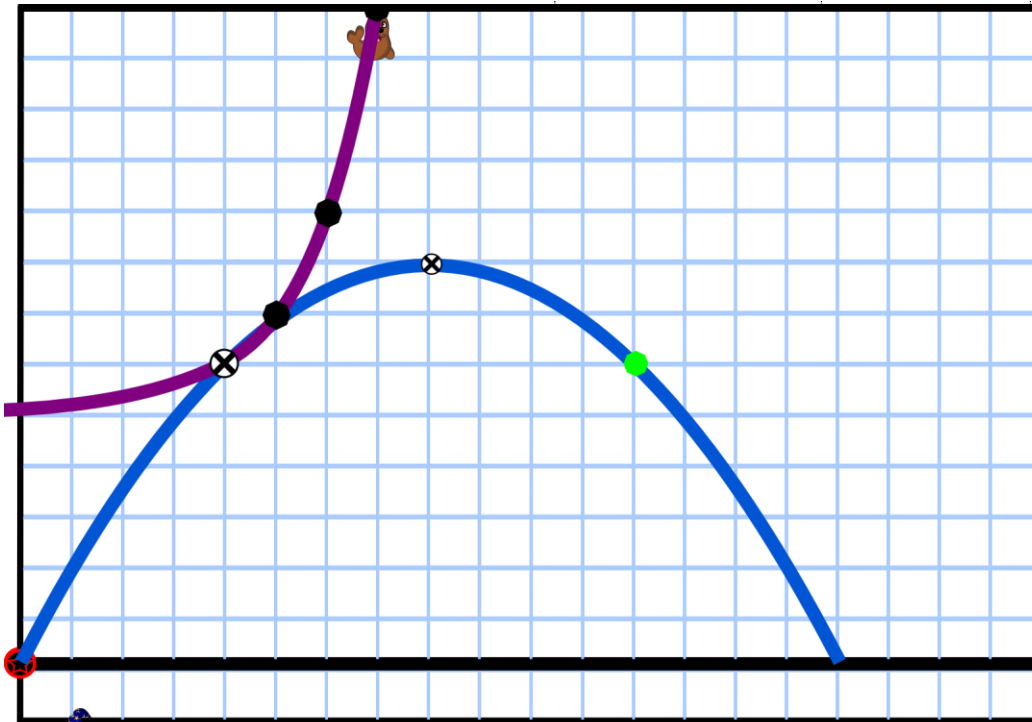
$$y = -\sqrt{x - h} + k$$

iii. At what point will the penguin use its power-up?

(10, 5)



$$f(x) = \begin{cases} 3x - \frac{x^2}{4} & \text{if } 0 \leq x < 10 \\ -\sqrt{x - 10} + 5 & \text{if } x \geq 10 \end{cases}$$



$$f(x) = \begin{cases} 2x - \frac{x^2}{8} & \text{if } 0 \leq x < 4 \\ 2^{(x-4)} + 5 & \text{if } x \geq 4 \end{cases}$$

- EXERCISE 4 -

i. Which Penguin is being used in this exercise?

Wizard Penguin

ii. What is the general equation of that penguin?

$$y = 2^{(x-h)} + k - 1$$

iii. At what point will the penguin use its power-up?

(4, 6)

Use the cutouts from the *Launch Path & New Recruits* handouts.
Sketch the functions on the graph and write piecewise functions of the result.

- EXERCISE 5 -

i. Which Penguin is being used in this exercise?

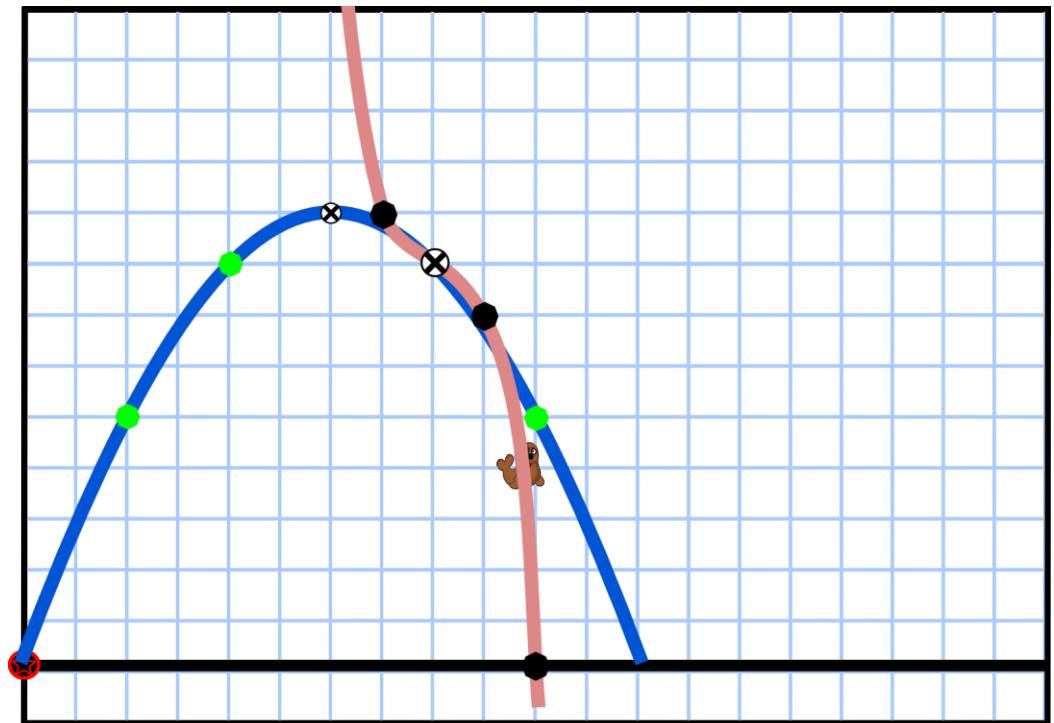
Pilot Penguin

ii. What is the general equation of that penguin?

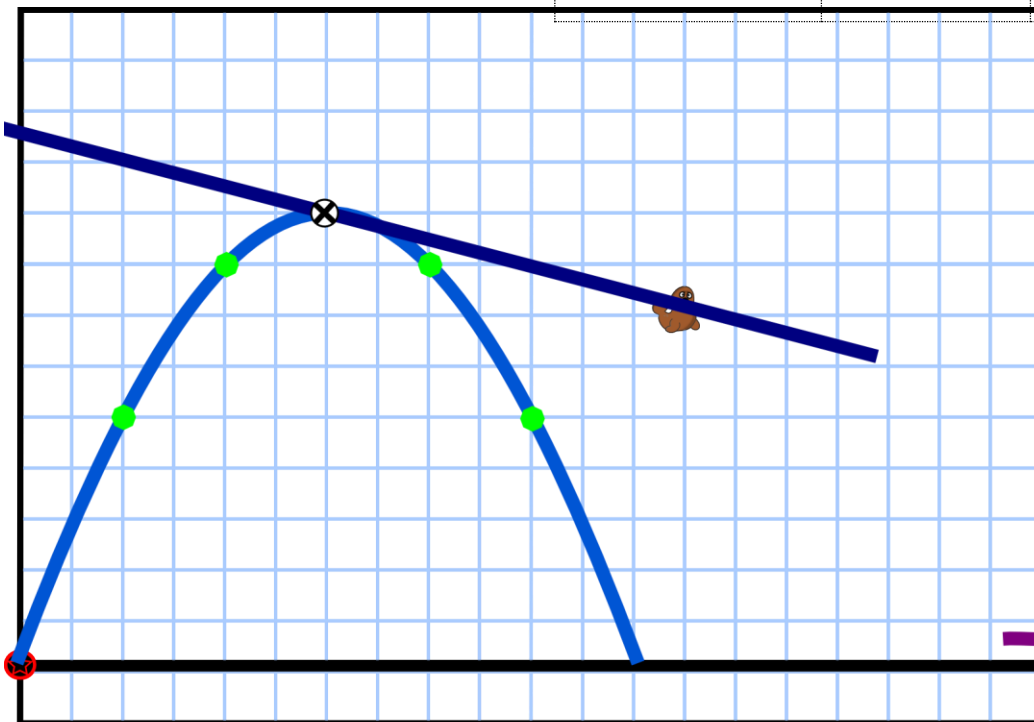
$$Y = (x-h)^3 + k$$

iii. At what point will the penguin use its power-up?

(8,8)



$f(x) = \left\{ \begin{array}{l} 2x - \frac{x^2}{8} \\ (x-8)^3 + 8 \end{array} \right.$	if	$0 \leq x < 8$
	if	$x \geq 8$



PICK YOUR OWN PENGUIN

$f(x) = \left\{ \begin{array}{l} \\ \end{array} \right.$	if	$0 \leq x <$
	if	$x \geq$

- EXERCISE 6 -

i. Which Penguin will you use in this exercise?

Answers will vary. In that example, I chose Hunter Penguin

ii. What is the general equation of that penguin?

iii. At what point will the penguin use its power-up?

ANGRY PENGUINS

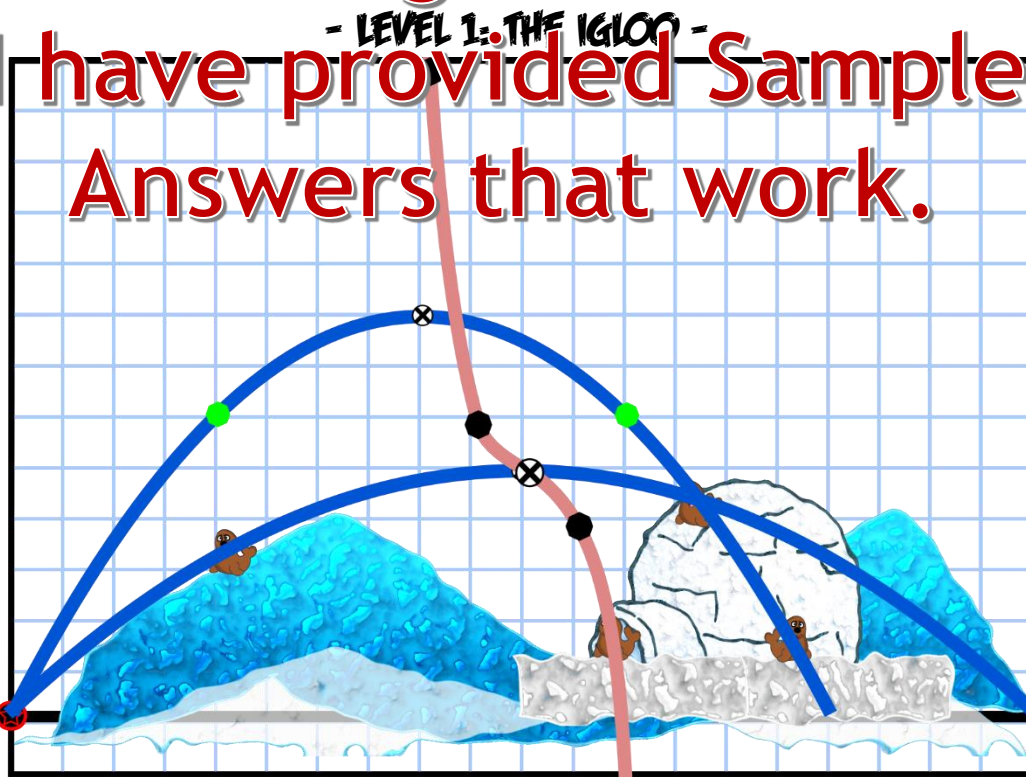


It's time to put all the skills to use. Bird tossing will never be more fun than in a mega-super-exclusive version of everyone's favorite Piecewise Function game *Angry Penguins*. Players will be given a limited supply of Penguins for each round. The player will select one of four parabolic paths to launch a penguin. If the penguin has a Power-Up, it can be activated on points with integer coordinates. If a line of a path intersects a Seal, the Seal is "poofed". The object of each level is to "Poof" all of the Seals. If you launch Penguins left over on each level, you will receive no bonus.

On each level, you will need to sketch the path of each function that you are using. Use the cutouts provided in *Launch Paths* and *New Recruits* to decide what choices to make. After you have chosen a path, you will need to record it as a single function. Each level will give you a template provided. What are you waiting for? Go poof those Seals!

All Solutions will Vary in this assignment.

- LEVEL 1: THE IGLOO -
I have provided Sample Answers that work.



PENGUIN

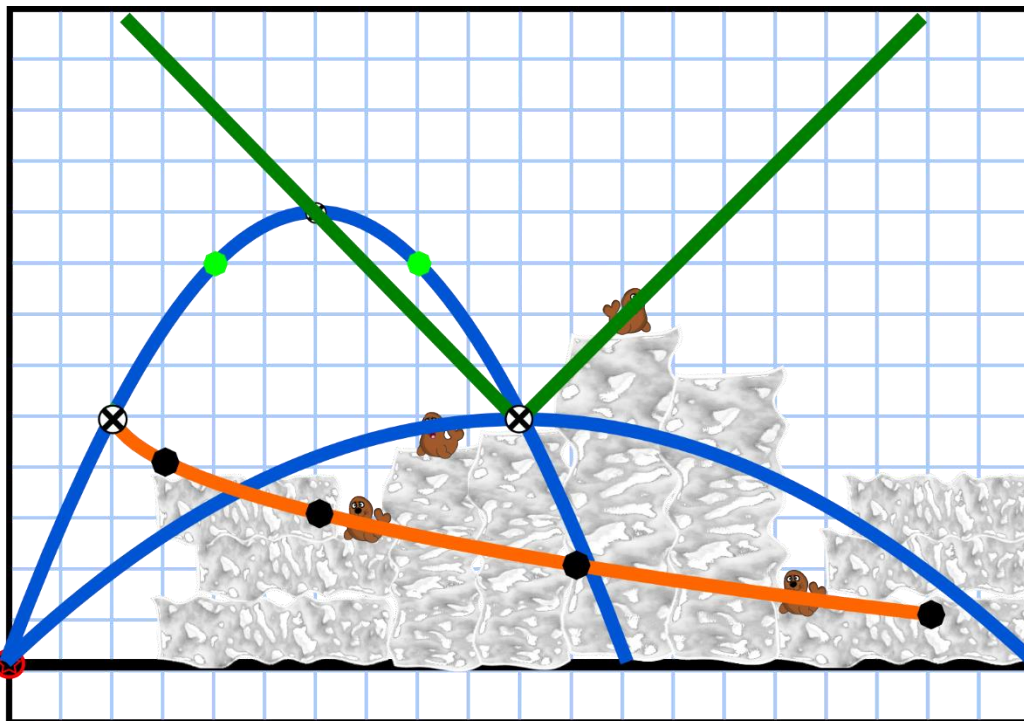


EQUATION

SEALS POOFED

1. Kung Fu		$2x - \frac{x^2}{8}$		2
2. Pilot	$f(x) = \begin{cases}$	$x - \frac{x^2}{20}$	if	$0 \leq x < 10$
		$-(x - 10)^3 + 5$	if	$x \geq 10$
				2

= LEVEL 2: THE GLACIAL MASS =



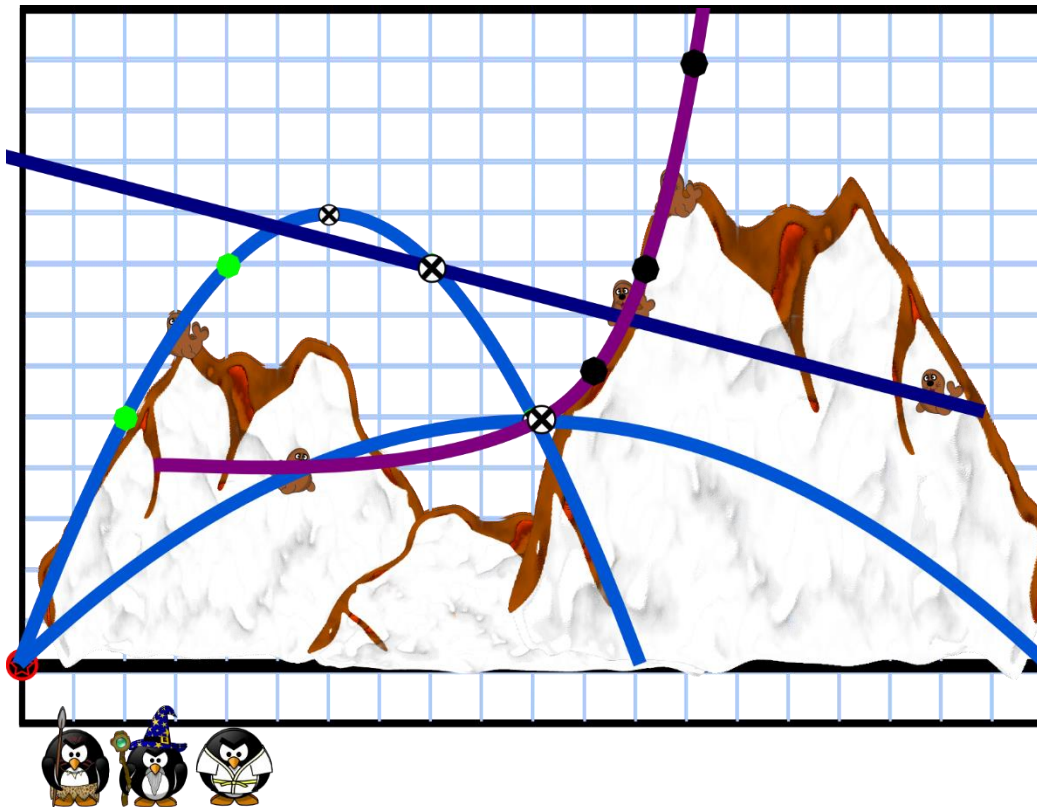
PENGUIN

EQUATION

SEALS POOFED

1. Pirate	$f(x) = \begin{cases} 3x - \frac{x^2}{4} & \text{if } 0 \leq x < 2 \\ -\sqrt{x-2} + 5 & \text{if } x \geq 2 \end{cases}$	2
2. Surgeon	$f(x) = \begin{cases} x - \frac{x^2}{20} & \text{if } 0 \leq x < 10 \\ x - 10 + 5 & \text{if } x \geq 10 \end{cases}$	2
3.		

- LEVEL 3: THE TALL MOUNTAIN LEVEL -



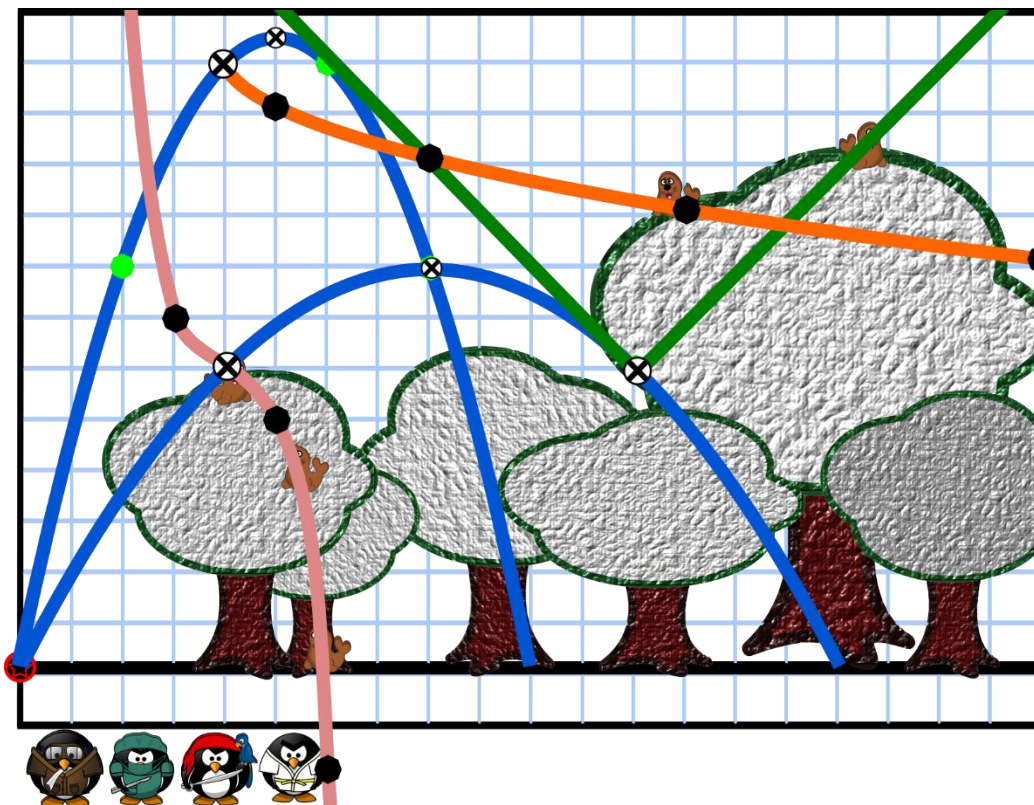
PENGUIN

EQUATION

SEALS POOFED

1. Hunter	$f(x) = \begin{cases} 3x - \frac{x^2}{4} & \text{if } 0 \leq x < 8 \\ -1/4x + 10 & \text{if } x \geq 8 \end{cases}$	3
2. Wizard	$f(x) = \begin{cases} x - \frac{x^2}{20} & \text{if } 0 \leq x < 10 \\ 2^{(x-10)} + 4 & \text{if } x \geq 10 \end{cases}$	2
3.		

- LEVEL 4: PETRIFIED FOREST -



PENGUIN

EQUATION

SEALS POOFED

1. Pilot	$f(x) = \begin{cases} 2x - \frac{x^2}{8} & \text{if } 0 \leq x < 4 \\ -(x-4)^3 + 6 & \text{if } x \geq 4 \end{cases}$	2
2. Surgeon	$f(x) = \begin{cases} 2x - \frac{x^2}{8} & \text{if } 0 \leq x < 12 \\ x-12 + 6 & \text{if } x \geq 12 \end{cases}$	1
3. Pirate	$f(x) = \begin{cases} 5x - \frac{x^2}{2} & \text{if } 0 \leq x < 4 \\ -\sqrt{x-4} + 12 & \text{if } x \geq 4 \end{cases}$	1
4.		

